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A New Method of Calculating the Cubic Contents of Excavations and Embankments.—By JOHN C. TRAUTWINE, C. E.

There is but one correct principle upon which to calculate the cubic contents of excavations and embankments; and that is, by means of what is known as the *Prismoidal Formula*, or Rule.

This Rule is as follows:

Add together the areas of the two parallel ends of the prismoid, and four times the area of a section half way between and parallel to them; and multiply the sum by one-sixth of the length of the prismoid, measured perpendicularly to its two parallel ends.

Since, in railroad measurements, the prismoids are generally 100 feet long, it becomes easier in practice to multiply the sum of the areas by 100, (by merely adding two cyphers,) and to divide the product by 6; which amounts to the same thing as multiplying their sum by $\frac{1}{6}$th of 100 feet.

The very general application of the prismoidal formula to other solids than such as are generally understood by the term "prismoids," has been shown by Mr. Ellwood Morris, Civil Engineer, in an able paper published in the Journal of the Franklin Institute. *Vol.* XXV, 2d Ser. *p.* 381.

It embraces all parallelopipeds, pyramids, prisms, cylinders, cones, wedges, &c., whether regular or irregular, right or oblique; together with their frustra, when cut by planes parallel to their bases; in a word, any solid whatever, which has two parallel ends, connected together by plane or unwarped surfaces.

In the cylinder and cone, the sides may be considered as consisting of an infinite number of indefinitely narrow unwarped planes. In railroad cuttings, it rarely happens that the ground surface lying between two consecutive cross sections 100 feet apart, is absolutely unwarped; yet, for practical purposes, it may very frequently be assumed to be so. When much warped, the cross sections must be taken closer together than 100 feet.

There are generally two circumstances under which it is necessary to ascertain the cubic contents on a public work; viz: first, after a preliminary survey of one or more *trial lines*, for the purpose of determining *approximately* their actual or comparative costs; and, second, after the final adoption and staking out of the determined route, in order to know *precisely* the amount of work to be done.

The measurements for the latter are performed with considerably more care, and attention to detail, than those of the former, inasmuch as upon them depend the payments to be made to the person who executes the work. They, moreover, involve considerations which cannot be attended to during a preliminary survey, without incurring an expenditure of time and labor, more than commensurate with the importance of the result.

When the ground is *level* transversely of the line of survey, there is no difficulty whatever in ascertaining the contents from a table of *level cuttings*, previously calculated; but when the ground is *inclined* or *irregular* transversely, the calculations have hitherto been attended with considerable labor.

The following method by diagrams, devised by myself during my probation as an assistant, and now communicated for the first time, will, I trust, be found to render the operations in the last cases nearly as simple and expeditious as in those of level ground; or, at least, infinitely more so than the usual ones. It dispenses with a great deal of calculation, and is, therefore, comparatively free from liability to error arising from that source.

The construction of the diagrams is extremely simple, notwithstanding that, at first sight, they appear somewhat complex. They are but few in number, since any particular road will generally require but three or four, which may be prepared by one person in a day. Before proceeding to explain the manner of drawing them, I will give one or two examples of their use, that the reader may see the object aimed at, and to what extent it is attained.

Example 1. Suppose that in a roadway of 28 feet wide, and with side-slopes of $1\frac{1}{2}$ to 1, the cutting at a certain station is 20 feet; and that the ground, instead of being level transversely, inclines at an angle of 15°.

Turn to the diagram for a roadway 28 feet wide, with side-slopes of $1\frac{1}{2}$ to 1: place a finger on the centre line, at the height of 20 feet, and run it along up the curved line which commences at that point, until it strikes the inclined line marked 15°. It will be seen at once that the two coincide at the height of 22·8 feet: *and this is the depth of the equivalent level cutting, which would have precisely the same area as the section under consideration.*

All such cases may therefore be instantly, and without any calculation whatever, reduced to others of *equivalent level cuttings.*

This constitutes the main feature of the principle involved in the diagrams.

Had the depth been 20·3, or other decimal of a foot, the proceeding would have been the same as with the 20 feet; and the equivalent level cutting would be found on the inclined line 15°, at the distance of ·3 of a foot (estimated by eye) above the curved line 20.

Example 2. Using the same diagram; let the depth of cutting be 2 feet, and the transverse slope of the ground 20°. Here, placing a finger on the centre-line, at the height of 2 feet, and running it along the curved line commencing at that point, it will be found that before reaching the inclined line of 20°, it encounters the dotted curved line drawn near the bottom of the diagram. When this occurs, we know that the ground-slope cuts the roadway, forming a cross section, partly in excavation, and partly in embankment, as in fig. 7.

This is a most useful check; for in such cases, the contents cannot be obtained by means of the diagram; but recourse must be had to a figure of the section, drawn for the purpose; as must also be the case when the ground is *irregular* transversely. A very simple method of proceeding, in all such cases, will be given further on.

I trust that what has been already shown, will satisfy the reader that my method partakes of utility, as well as of novelty.

On the page opposite each diagram, is a table of cubic yards for level cuttings, and for lengths of 100 feet. By means of this, the cubic contents may at once be taken out, when the equivalent level cuttings at both ends of a station are equal: but if they are not so, the prismoidal rule must be employed, thus:

Suppose the equivalent level cutting at one end to be 20 feet, and at the other 25 feet. Then, that at a point half way between them would be 22½ feet. Therefore, the cubic content will be equal to one-sixth of the sum of those corresponding to each of the two end depths, and four times that of the centre depth; that is,

Cubic content by table IX, for 20 feet depth = 4296 cubic yards,
" " " " " 25 " = 6065 " "
Four times " " " 22½ " } = 20584
or 4 times 5146 }
6)30945
Cubic yards contained in the station, = 5157·5

It will be perceived that, instead of the *areas* corresponding to the different depths of cu ting, or heights of filling, our tables give the *cubic yards* corresponding to those areas, for lengths of 100 feet. For the purposes of calculating cubic contents, these solidities may evidently be used instead of the areas; but for such cases as require the areas themselves, a table of such is added. Its use will be shown further on.

I will here observe, that for mere *comparative* estimates of trial lines, the labor may be much reduced by taking from the tables, the cubic content corresponding to the *average* of the equivalent level cuttings at the two ends. This mode is, of course, by no means mathematically correct, and should never be resorted to for final estimates; but it will frequently

be sufficiently approximate (always a little deficient) for such trapezoids as occur in ordinary cuttings and fillings, where the depths at the two ends differ but a few feet.

For instance, in the foregoing example, the correct contents of the station 20 feet deep at one end, and 25 feet at the other, were found to be 5157·5 cubic yards; while by this approximating mode, the contents of an *average* equivalent level depth of 22½ feet, would be 5146 cubic yards; or but 11½ yards less than the truth.

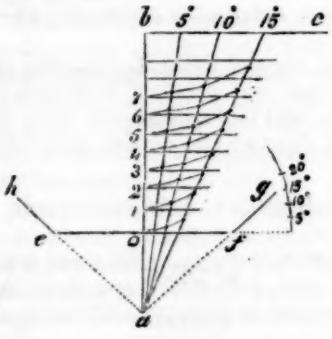
In this manner, an entire cut or fill may be approximately estimated at one operation, by merely adding together all the average midway equivalent level cuttings or fillings, and dividing their sum by their number for an average one.

Thus, if the average midway equivalent level depths of 6 consecutive stations of cuttings, were respectively 2, 5, 6, 4, 3, 7 feet, an average depth might be taken of $\frac{2+5+6+4+3+7}{6} = 4{\cdot}5$ feet; and the cubic contents taken from the proper table, for a depth of 4·5 feet, and multiplied by 6, (the number of stations,) would give the contents of the whole 600 feet, but slightly too little.

I will now proceed to describe the mode of preparing the diagrams, for any width of roadway, and for any side-slope whatever.

The determination of the *principle* on which they are formed, is left as a problem for such of the younger members of the profession as may choose to exercise their ingenuity upon it.

Fig. 1.



Draw a vertical line *a b*, fig. 1, of any given length at pleasure. (One foot decimally divided; or 12½ inches, divided into ⅛ths of an inch, or 10 inches divided into $\frac{1}{10}$ths of an inch, will generally be found convenient.) Call the length of this line unity, or 1. It represents the usual centre-line of levels, or of cuttings and fillings.

From the upper end of this line draw *b c*, at right angles to it; and from *b* towards *c*, lay off and number the distances *b*5°, *b*10°, *b*15°, &c., contained in the following table; using as a scale, the length *a b*, as 1 or unity, divided into tenths and hundredths.

For example, if the side-slopes *h e*, *g f*, of the excavation or embankment, are ¼ to 1, lay off (without any regard to the width of roadway,) the distances on the upper column of the table; if 1 to 1, those on the 2nd column, &c. This done, the scale of *a b*, *as unity*, will be of no further use.

Distances on *b c*, intermediate of those in the table, may be inserted with sufficient accuracy by eye.

Those beyond 20° will rarely be required, because, when the transverse ground-slope is great, retaining walls are resorted to as a matter of economy.

Table of Distances from b, *to be laid off on the Horizontal Line* b e, *Fig.* 1.

Side Slopes.	10°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
¼ to 1, or 78° 58′	·005	·011	·014	·017	·022	·026	·032	·038	·046	·057	·073	·099
	5°	10°	13°	15°	18°	20°	23°	25°	28°	30°	33°	34°
1 to 1	·044	·089	·117	·136	·167	·188	·222	·247	·288	·318	·369	·388
or 45°	35°	36°	37°	38°	39°	40°						
	·409	·431	·454	·480	·510	·543						
	5°	8°	10°	13°	15°	18°	20°	23°	25°	28°	30°	32°
1¼ to 1	·068	·108	·138	·184	·214	·264	·300	·358	·401	·476	·530	·600
or 38° 40′	34°											
	·685											
	5°	8°	10°	13°	15°	18°	20°	22°	24°	25°	26°	27°
1½ to 1	·097	·158	·201	·267	·314	·390	·445	·506	·574	·611	·652	·696
or 33° 42	28°											
	·747											
	3°	5°	8°	10°	11°	12°	13°	14°	15°	16°	17°	18°
2 to 1,	·106	·175	·285	·363	·404	·447	·489	·533	·580	·629	·683	·739
or 26° 34′	19°	20°	21°	22°	23°							
	·798	·865	·936	1·017	1·110							

From the different points *b* 5°, *b* 10°, *b* 15°, &c., (and from the subdivisions of single degrees between them, as in the working diagrams,) draw lines to *a*. From *a* upwards set off, by any scale at pleasure, (from $\frac{1}{12}$th to $\frac{1}{8}$th inch to a foot will be found convenient,) the distance *a o*, which is the height of the triangle *e f a*, formed by the prolongation of the side slopes *g f*, and *h e* to *a*; *e f* representing the width of the roadway, whatever it may be, on the same scale.

It is not necessary actually to draw *h a*, *g a* and *e f*, as we may set off *a o*, by recollecting that if the side-slopes are

¼ to 1, then *a o* will be 4 times *e f*, or width of roadway.
1 to 1, " " equal to *e f*.
1¼ to 1, " " ·8 of *e f*.
1½ to 1, " " $\frac{2}{3}$ of *e f*.
2 to 1, " " $\frac{1}{2}$ of *e f*.

Beginning at *o*, divide the vertical or centre line *o b*, by the same scale into feet, numbering them 1, 2, 3, &c., from *o* upwards; and from the points of division 1, 2, 3, &c., draw horizontal lines parallel to *b c*, as shown in fig. 1.

From *o* as a centre, lay off with a protractor, the several angles of transverse ground-slope as shown by the dotted arc in fig. 1. As before remarked, angles higher than 20° will seldom be required.

NOTE.—In fig. 1, the inclined lines, and also the angles on the dotted arc, are, for convenience, numbered only for every 5°; but in a *working* diagram they should be taken nearer together, for instance every, 2° to 3°.

Lay a parallel ruler from *o* to 5° on the dotted arc, and mark with a dot the point of intersection on the inclined line *a* 5°; then keeping the ruler in the same position, move it upwards along *o b*, stopping at every division of 1 foot, and making corresponding dots on the inclined line *a* 5°, as in fig. 1, continuing to such a height on the centre line as will include the greatest cutting or filling to be calculated by the diagram.

Then lay the parallel ruler from *o* to 10° on the dotted arc, and mark

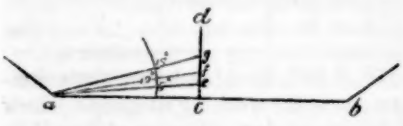
with a dot, the point of intersection on the inclined line *a* 10°; then keeping the ruler in the same position, move it upwards along *o b*, stopping at every division of 1 foot, making corresponding dots on the inclined line *a* 10°.

Then lay the parallel ruler from *o* to 15° on the dotted arc, and proceeding as before, make corresponding dots on the inclined line *a* 15°, and so on up to as high an angle as will equal the greatest transverse slope of the ground which occurs on the work to be calculated by means of the diagrams.

Finally, connect the corresponding dots on the several inclined lines, forming thereby a series of curves, as shown in fig. 1, and also in our working diagrams. The diagram is now ready for use, for all cases of ground-slope which do not intersect the roadway, thereby forming a section partly in excavation, and partly in embankment, as shown in fig. 7.

In order that the diagram itself may inform us when this is the case, the dotted curve shown near the bottom of the working diagrams is added. It is prepared as follows:

Fig. 2.



Let *a b*, fig. 2, represent the width of roadway, and *c d* the centre line of cuttings and fillings. From *a* as a centre, lay off with a protractor, the angles 5°, 10°, &c., and draw the lines *a e*, *a f*, *a g*, &c., to the centre line.

Now, suppose the height *c e*, corresponding to 5°, to be 2 feet. Mark on the working diagram, the intersection of the *curved* line of 2 feet with the inclined line of 5°. Suppose the height *c f* corresponding to 10° to be 4 feet; and mark on the diagram the intersection of the curved line of 4 feet with the inclined line of 10°; and so on with the rest. Then join their several marks of intersection, and the dotted curve is formed, and the diagram is finished.

The working drawings which I have given, are on a scale of $\frac{1}{10}$th of an inch to a foot, for convenience of insertion in this volume; yet, although the curved lines are drawn straight across several divisions of the inclined lines, (generally 5 of them,) they will rarely be found, in operating with them, to differ as much as $\frac{1}{10}$th of a foot from the truth.

They are adapted to such widths of roadway as I judged most likely to be adopted in ordinary practice; viz.: for single and double track embankments, 14 and 24 feet wide on top, and with side slopes of $1\frac{1}{2}$ to 1; and for single and double track excavations, 18 and 28 feet wide at bottom, with side slopes of from 1 to 1, up to 2 to 1.

The widths will rarely differ more than 2 feet from those for which the diagrams have been prepared. The most mistaken economist would hardly venture to make them more than 2 feet less; nor do I conceive that any advantage would attend making them more than 2 feet greater.

It is sometimes advisable to increase the quantity of excavation to be taken from a cut, in order to furnish earth for an adjoining embankment. When the value of land is not sufficiently great to constitute an objection, this may generally be most advantageously effected by merely increasing the side-slopes of the cut to 2 to 1; but, where that would not be sufficient, it

becomes necessary to increase the width of the cut at bottom also, and separate calculations must be made for the purpose.

No diagrams accompany the tables of level cuttings for side-slopes of $\frac{1}{4}$ to 1, which are used only for rock; because with this side-slope, the transverse inclination of the ground rarely affects the quantity of material to an important extent. Still, on every work on which much rock cutting occurs, a diagram should be prepared for the purpose.

Should other widths of roadway be adopted, new diagrams must be drawn for them; as also new tables of level cuttings calculated.

These new tables may be easily made by merely adding to or subtracting from the contents corresponding to every consecutive $\frac{1}{10}$th of a foot of depth in the tables of level cuttings, an additional ·741 of a cubic yard, for each 2 feet of width added or subtracted.

For example, suppose that the roadway, instead of 28 feet, is to be made 30 feet wide; with side slopes of $1\frac{1}{2}$ to 1. Here,

The Cubic Yards for a 28 feet Roadway are by the Table,		By the continual addition of ·741 of a Cubic Yard, we obtain,	Cubic Yards in a 30 ft. Roadway; equal to the sum of the two preceding columns,
Depth in feet.	Cubic Yards,		
·1	10·4	·741 ·741	11·1
·2	21·0	1·482 ·741	22·5
·3	31·6	2·223 ·741	33·8
·4	42·4	2·964 ·741	45·3
·5	53·2	3·705 ·741	56·9
·6	64·2	4·446 ·741	68·6
·7	75·3	5·187 ·741	80·5
·8	86·5	5·928 ·741	92·4
·9	97·9	6·669 ·741	104·6
1·0	109·3	7·410	116·7

Had the new roadway been 26 feet wide, instead of 30, the middle column would have been *subtracted from* the first, in order to form the third one.

It is not absolutely necessary to calculate new tables of level cuttings for widths differing 2 feet from those which I have assumed in the working diagrams. The contents of an excavation or embankment, may be taken from the nearest table, by means of the equivalent level cuttings deduced

from the diagrams; and an allowance be made afterwards for the 2 feet difference of width, by adding together all the depths, and dividing their sum by their number, for an average depth. The number of cubic yards taken from table 14, for this average depth, and a width of 2 feet, will, when multiplied by the number of 100 feet stations in the cut or fill, be correctly the amount to be added to, or taken from, the quantity previously obtained from the tables.

While the width of roadway remains the same, a separate diagram is required only for each side-slope; so that when the roadway has the same width in cuttings, and on embankments, with side-slopes of $1\frac{1}{2}$ to 1 in both, but one diagram is necessary for the entire road.

But, generally, the roadway is wider in the cuts than on the embankments; requiring at least one diagram for embankments, with side-slopes of $1\frac{1}{2}$ to 1, and one for excavations, with such side-slopes as may be adopted.

Frequently one will be required also for rock cuttings, of $\frac{1}{2}$ to 1; and if different side slopes of excavation are employed in different kinds of soil, a diagram must be prepared for each side-slope.

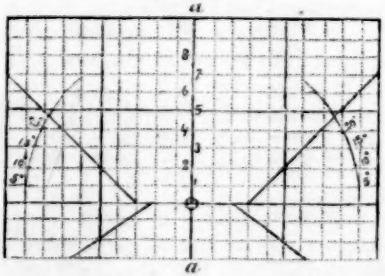
An entire set for any particular road, may be completed by a ready draughtsman, in a day.

Cases of Ground Irregular Transversely.

All cases of irregular transverse ground-slope, (except that in which the ground-slope intersects the roadway, as in fig. 7,) may easily be reduced, by drawings, to such a form that their equivalent level cuttings may be obtained by means of diagrams, and the corresponding contents taken out from the tables.

For this purpose, it is very convenient to have paper of about 14 by 24 inches, ruled across in both directions, with parallel lines about $\frac{1}{10}$ of an inch apart, as in fig. 3.

Fig. 3.



Every fifth line should be stronger than the intermediate ones, if drawn or engraved; or of a different color, if ruled by a stationer. By means of the multiple ruling pens used by stationers, this paper is ruled to order, at a very trifling cost.

When this ruled paper is prepared for use at leisure moments, according to the following directions, nothing more will be required in order to obtain the data for the subsequent calculations, than a parallel ruler about 2 feet long. Those flat rulers which move on rollers are greatly preferable to those with hinges, which invariably get out of order in a short time.

The ruled paper is prepared as in fig. 3, by drawing upon some sheets, outlines of the side-slopes of an excavation, with a small piece of embankment below it; and upon others, the side-slopes of an embankment, with a small piece of excavation above it.

The heights, or depths, should be numbered along the centre line, as in fig. 3.

Finally, lay off on both sides of *o* as a centre, by means of a large protractor, single degrees up to as high as the greatest transverse ground slope for which the paper is to be used; this, as before remarked, will rarely exceed 20°; because, with high transverse ground-slopes, it is generally better to resort to retaining walls.

The paper is now ready for use, and all the subsequent operations may be performed by the parallel ruler.

One sheet may be made to serve for the calculations of many stations, by merely drawing in the transverse ground slopes, *very lightly*, with lead pencil marks, which may be rubbed out as each station is finished.

It is advisable, however, in *very irregular* sections, to represent but two consecutive ones on one sheet; and after having drawn them in ink, and added the numbers of the sections or stations to which they belong, as well as the cubic content comprised between them, to lay them aside for future reference, in case of dispute with the contractor, after the work is commenced.

The method which I advise for reducing irregular cross sections to equivalent regular ones, which may be calculated by means of the working diagrams and tables of level cuttings, is as follows:

CASE 1.—*When the ground slopes differently from the centre each way, as e d, e a, in figs.* 4 *and* 5.

Fig. 4.

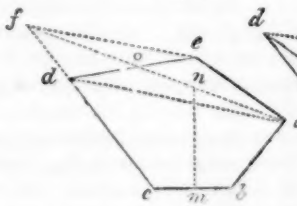
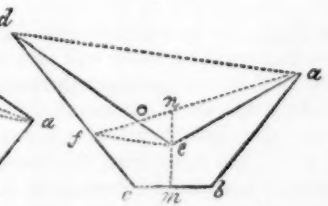


Fig. 5.



On the prepared paper, fig. 3, from the centre height or depth *e*, figs. 4 and 5, and by means of the parallel ruler, and the degrees marked on the sheet, fig. 3, draw the two slopes *e d*, *e a*, figs. 4 and 5; the inclinations of which are taken from the field slope-book. Draw *e f*, parallel to *a d*, and join *a f*. Then is *a b c f* equal to *a b c d e*,* figs. 4 and 5.

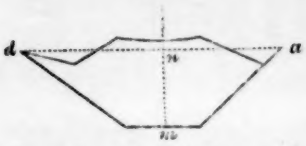
Find by means of the parallel ruler and the degrees marked on the paper, the slope of *a f*; and with that slope, and the new centre depth *m n*, (which is had from the figure by inspection,) use the proper diagram for finding the equivalent level cutting; and take out the cubic yards from the table.

Also, in fig. 5, the triangles *f e d*, and *f e a*, being on the same base *f e*, and between the same parallels *f e*, *d a*, are equal to each other; and leaving out from each the triangle *f e o*, which is common to both, we have the triangle *f o d*, *e o a*, and consequently *a b c f* = *a b c d e*.

* *Proof.*—The two triangles *a d f*, *a d e*, fig. 4, being on the same base *a d*, and between the same parallels *a d* and *e f*, are equal to each other. Leaving out from each, the triangle *a d o*, which is common to both, we have the triangle *d f o*, equal to the triangle *a e o*; and consequently *a b c f* is equal to *a b c d e*.

CASE 2.—*When the ground is very irregular transversely, as in fig.* 6.

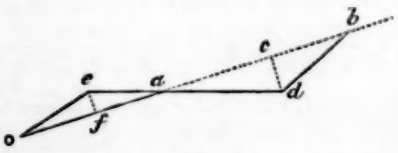
Fig. 6.



Having drawn the figure on the prepared paper, find by trial with a piece of thread, the line *a d*, which equalizes, as nearly as can be judged by eye, the irregularities above and below it. By means of the parallel ruler, and the degrees on the paper, find the slope of *a d;* and with that slope, and the new centre depth *m n*, (which is had from the figure by inspection,) use the proper diagram for finding the equivalent level cutting; and take out the cubic yards from the table.

CASE 3.—*When the ground slope intersects the roadway, as in fig.* 7.

Fig. 7.



Such cases are always detected by the dotted curve line in the working drawings.

Having drawn the figure on the prepared paper, measure the two bases *a b* and *a o;* and also the two perpendiculars to them, *c d* and *e f*.

Multiply *a b* by *c d*, and half the product is the area of the triangle of excavation *a b d*. If the triangle of excavation at the other end of the 100 feet station, has the same area, the number of cubic yards corresponding to this area for a length of 100 feet will be taken from table 15.

Also multiply *a o* by *e f*, and *half* the product will be the area of the triangle of embankment *a o e*. If the triangle of embankment at the other end of the 100 feet station, has the same area, the corresponding number of cubic yards will be taken from table 15.

But if the triangles of excavation, (or those of embankment,) at the two ends, are not of the same area, the trapezoidal rule must be employed, as in the case of trapezoidal cross sections of unequal areas. See page 3.

That is, we must add together the contents of the two end triangles, and 4 times that of the triangle half way between them, and divide their sum by 6, for the true content.

The base of the centre triangle of excavation, will be the average between the two bases *a b*, fig. 7, at the ends; and its perpendicular, the average between the two perpendiculars *c d*, at the ends.

In like manner, the base and perpendicular of the centre triangle of embankment, will be averages of the two end bases *a o*, and of the two end perpendiculars *e f*.

If from irregularities in the ground, in the direction of the line of the road, it should become necessary to take cross sections nearer together than 100 feet, only the same proportional parts of the cubic yards must be taken from the tables; and on this account, it is better always, when possible, to subdivide the 100 feet station distances into such parts as will furnish numbers easy to divide by; thus, if the station be divided into 10, 20, 25, or 50 feet distances, they will furnish respectively the numbers 10, 5, 4, or 2, by which to divide the cubic yards in the tables, all of which are calculated for 100 feet distances.

To find the Distances of the Side Stakes from the Centre Stake.

In all cases in which the cross sections are drawn, as just described, these distances may be had by measurement on the figures.

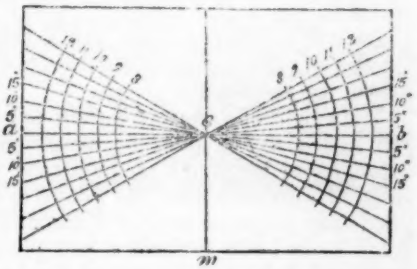
But they may be obtained much more rapidly thus: prepare a piece of tracing paper, as in fig. 8, of the same size as the ruled paper on which the cross sections are drawn.

From *c* as a centre, lay off and number the degrees, as marked at the ends, to as high as the greatest transverse ground slope in the work.

Also, from *c* as a centre, draw by the same scale as the ruled paper, fig. 3, arcs of circles one foot apart, and number them with their distances from *c* in feet.

Then, by laying this paper upon a cross section of the road, fig. 3, with *c* of fig. 8, placed at the given centre height or depth on the line *a a*, of fig. 3, we at once read off, without any calculation whatever, the distances of the side stakes from the centre stake, measured along the transverse ground slope. These distances will be copied into the proper book for field use.

Fig. 8.



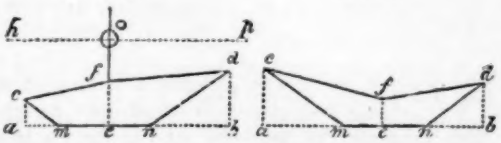
If, instead of concentric arcs, vertical straight lines are drawn on the transparent paper, we shall in like manner obtain, by mere inspection, the *horizontal* distances of the side stakes from the centre one. When the horizontal distances are used in preference to those measured along the transverse ground slope, it is necessary to use a plumb at the end of the measuring line, in order to hold it vertically over the centre, or the side stake, depending upon which is lowest.

The tracing paper figure should be pasted to a frame, so as to lie flat on fig. 3. The frame may be of stiff pasteboard.

On the Usual Method of Calculating Excavations and Embankments.

Different engineers employ different methods, of which the following is, perhaps, as simple as any:

Fig. 9. Fig. 10.



It requires that there shall be given, (beside the width of roadway *m n*, figs. 9 and 10, and the side-slope,) the extreme *horizontal* width *a b* of the cut, or embankment; and the vertical depths *f e* at the centre; and *c a*, *d b* at the sides.

The Rule then is, *multiply the extreme horizontal width* a b, *by half the centre depth* f e; also multiply ONE-FOURTH *of the width of roadway* m n,

by the sum of the two side depths c a *and* d b: *the sum of the products will be the area of the cross section* m n d f c, *fig.* 9 *or fig.* 10.

This area, thus found, multiplied by 100, (the usual length of the station in feet,) and divided by 27, (the number of cubic feet in a cubic yard,) gives the cubic content of the station, provided the area of the cross section at the other end of the station be the same; but if not, the prismoidal Rule must be used, as already explained.

The trouble of multiplying by 100, and dividing by 27, may be avoided by the use of table 15, which I have prepared for that purpose.

The centre depths *f e*, fig. 9 and 10, are given by the level book; but the side depths *c a* and *d b*, have to be found by trial on the ground, thus: The level is placed conveniently for sighting from the same position upon *f*, *c*, and *d*.

A sight *f o*, is first taken on the target rod held at *f*; this sight *f o*, being added to the centre depth *f e*, gives the height *e o*, of the instrument above *a b;* or the horizontal plane, (represented by *h p*,) through which the line of sight passes as the telescope of the level is swept round on the axis of the instrument.

The height of *d* above *f* is then estimated by eye, say at 2 feet; this 2 feet, added to *f e*, gives the *approximate* height of *d b*. Assuming the approximate height *d b* as the correct one, we find what would be the *horizontal* distance from the centre to *d*, either by calculation, or from a previously prepared table of horizontal distances. Measure off that distance horizontally towards *d*, and placing the target 2 feet lower on the target rod, hold it at the end of the measuring distance. A sight is then taken with the level, and if it strikes the centre of the target, it proves that the assumed height of *d*, and the corresponding horizontal distance from the centre of the roadway, were correct; and that the proper spot is found for placing the side-stake *d*.

It seldom happens that such a coincidence is found at the first trial; at least two trials are generally required; and frequently three, or even four when the ground is extremely irregular.

A very close approximation, however, can always be made by an experienced leveller after the first trial. An error of an inch or two in the position of a side-stake is a matter of no practical importance whatever.

The same operation is performed at *c*, except that as *c* is *lower* than *f*, the target is *raised* on the rod, as far above the sight taken at *f* as *c* is estimated to be below *f*.

(When putting in side-stakes for an *embankment*, the sight taken on the rod at the centre stake, is *subtracted* from the centre height of the embankment, in order to obtain the depth of the instrument below the roadway.)

It is plain that if the height on the target rod at *d*, fig. 9, be subtracted from *e o*, the remainder will be *d b*; and that taken at *c*, subtracted from *e o*, will give *c a*.

These operations give us therefore, at the same time, the heights *d b*, and *c a*; and also the horizontal distances from the centre to each side stake. All these are at once entered into the proper field-book, to be used in estimating the areas and cubic contents in the office.

The sum of the two horizontal distances manifestly gives the extreme width of the excavation or embankment.

It is evident, that in the time required for a leveller and rodman to ascertain the positions and heights of the side-stakes, at a single station, by this method, those of several stations could be found by one person in the office, by mine.

Still, in some rare cases, where the ground-slope is extremely irregular, as among jagged rocks, the mode by the level is the only one proper to be used; as, in that case it would be impossible to take the transverse ground-slopes with any degree of accuracy.

Transverse ground-slopes are obtained in the field with great facility, by means of a small slope level, or *clinometer*, placed upon a rod, 10 or 12 feet long, which, at every station, is laid upon the ground as near at right angles to the line of survey, as can be judged by eye. These clinometers are sold by most of our principal instrument makers.

When the ground is regular transversely, but one slope need be taken; at other times, one may be required from the centre each way; and rarely, more than one on each side of the centre-stake. The slopes for estimating the final adopted line, must be taken with much more care than during preliminary surveys of trial lines. They need not, however, extend beyond the widths actually occupied by the cuttings and fillings; while those taken in preliminary surveys, should comprise a considerable width, as they are, moreover, used in the office for changing the position of the surveyed line, in order to avoid excavation and embankment.

To be Continued.

For the Journal of the Franklin Institute.

On the Comparative Qualities of the Metal Employed in the Construction of Railroads. *By* Hu. L. Damsel.

Now that the demand for railroads has become so extensive, though limited to such as promise to be directly profitable to their proprietors or beneficial to the community at large, the comparative qualities of the metal employed in their construction, deserves to be more closely investigated than has hitherto been done. The subject is one which has not received that attention and examination from scientific men, which its direct connexion with the successful working of railroads demand. Large sums are annually paid for rail-bars which may or may not be applicable to the purposes for which they are intended. They may last many years under a heavy traffic, or their duration may not exceed a few months of comparatively light traffic. The probabilities are as much in favor of one as the other.

On the introduction of railroads, engineers were of opinion that iron railway bars would endure for an indefinite period, and that their destruction would eventually be effected by the oxydation of the metal from its exposure to atmospherical changes. But a real iron way had not long been constructed and in use, before it was discovered that the iron bars were subject to abrasion and disintegration, by the sliding and rolling of the locomotive engines and carriages that traversed it, and that on lines having a considerable traffic worked at high speeds, their destruction was effected within a very limited period. The injury to the

rails from oxydation of the surface is scarcely perceptible on those constantly in use. The abrasion of the head of the rail, thereby diminishing the width and depth of the bars, is on some railroads, under certain conditions, the means of lessening the duration of the rails. But lamination, or a disintegration of the fibres of the metal composing the wearing part of the rail, is a fruitful source of expense on numerous railroads in Europe and America.

No sooner, however, was it discovered that the bars were liable to laminate and splinter, than a number of inventions were produced with the view of obviating the evil, and their projectors, impressed with the idea that the shape of the rails was faulty, promulgated the most ridiculous designs that can be imagined. Flat bars were proposed as the least liable to laminate, and these, if unattended with other objections, would probably be the cheapest of any. Indeed, where bar iron is expensive, timber cheap, and the traffic light, the flat plate rail is perhaps the most economical that can be adopted. Square bars, it was supposed, could be laid on their different sides in succession as each became worn, until reduced to the size of a nail rod. Round rods were gravely recommended as still superior, for they, it was imagined, could be turned around a fraction of a circle, so as to offer a fresh bearing surface, whenever it was required: the operation being repeated until the rod was reduced to a mere skeleton of its former self. Parallel rails with head and foot alike were proposed, and in many instances adopted, from the mistaken idea, that when one side was worn they could be reset in an inverted position, and thus be as good as new—forgetting altogether that the inverted rail would not fit the others in height, nor the chairs in section. But, lest the upper and under sides of the parallel rail should not afford sufficient wearing surface, rails with three and others with four heads have been invented and patented.

Meanwhile, railroad companies have adopted almost every variety of section. Parallel, T or web-footed, bridge, and plate rails have been used with more or less success. From the diversity of opinion which exists among engineers respecting the best section for iron rails, it may justly be inferred, that of itself it is a matter of very little importance. In England the bridge, and parallel rails, and in the United States the plate, and web-footed rails, are the prevailing sections; while on the Continent of Europe, bridge, parallel, web-footed, and plate rails are used indiscriminately on the same line of road. This diversity of opinion among engineers respecting the best section for a rail bar descends also to their proportions, for while one engineer constructs web-footed rails of a given weight per yard, 3 inches high and $1\frac{1}{2}$ inches thick, another fashions the same weight of metal into a rail 8 inches high, and but $\frac{1}{2}$ inch thick in the centre. The bridge rails originally on the Great Western Railway, in England, were but $1\frac{1}{4}$ inches high; those laid on some Irish railways were 4 inches high.

The occurrence of lamination in the rails may be traced to one or more of the following causes: 1st, From the line of rails being unsupported with a sufficiency of suitable sleepers and ballasting. 2d, From the improper state of the working stock. 3d, From a disproportion between the quantity of metal in the bars, and the weight of the locomotive

engines and rolling load, and the velocity at which these are propelled. 4th, From the imperfect and negligent manner in which the bars are too often manufactured. 5th, From their having been manufactured from improper metal.

The condition of the permanent way has an important connexion with the duration of the rails. If the ballasting has originally been made of unsuitable materials, or if it has since been negligently maintained, the very best rails are as liable to injury from this cause as the very worst. It matters not what care may have been taken in their manufacture, if the rails are not properly supported at necessary intervals, or, what is better, continuously, crushing and lamination will ensue. With rails supported on transverse sleepers at fixed bearings, the slackness of a sleeper will be sufficient to laminate a rail, which otherwise would have remained sound for years. And too great a distance between the bearings, in proportion to the depth of the rail, and weight of the loaded wagons, is attended with similar consequences.

Laying the rails on longitudinal strings of timber is certainly the best mode of fixing them, and one that ought to be more generally adopted. To be really effective, however, the pieces should be of larger scantlings than those hitherto used, and maintained carefully packed up by the ballasting. By using larger timber, the injury to the rails from the deflexion of the stringers would be reduced to very narrow limits.

The state of the rails on bridges formed of wood or metal, offers instructive examples of the injury which may result to the rail bars by their deflecting considerably from a right line.

Injury may also be occasioned to the rails by the use of badly constructed carriages, wagons, and other working stock. Carriages and wagons without bearing or other springs, are more injurious than those fitted with such springs, though not to the extent generally supposed. The beneficial application of such springs is limited to passenger and other carriages running at high velocities. For the conveyance of minerals, heavy goods, and lumber, generally at low speeds, wagons without springs are used in many localities with decided economy. The distance between the axles of the wheels and the height of the wagons affects the wear on the rails, as also does the materials of which the wheels and tyres are made, but to an inconsiderable extent compared with others.

As frequently being the direct cause of shearing and splitting of the rails, the condition of the wheel tyres belonging to the working and rolling stock, requires notice. When tyres of the usual width and gauge are much worn, a groove is sunk in the wearing part, and a shallow flanch, as it were, is formed on the outside of the tyre. In the ordinary course of working, this artificial shallow flanch will at times roll on the rail, and as the bearing surface which it presents is but a mere fraction, and that at the extreme outside of the rail, a place frequently made of diminished section, an immediate or ultimate severance of a narrow strip of the rail is the almost certain consequence whenever this occurs. When the wheel tyres are permitted to wear into grooves, whether from negligence or ideas of economy, the broken and splintered state of the outside edge of the rails is most evident. If permitted to do so, this ragging

and splintering of the rail bars will extend inwards, and ultimately occasion their renewal. But if, on the appearance of a groove in the tyre, the wheels are at once removed from use, and the tyres turned in a lathe to restore them to their original contour, the instances of lamination on the outer side of the rails, now so frequently observed, would be greatly lessened.

On the first railroads the rails were much too slight, even for the light engines and loads and moderate velocities which their promoters then contemplated as sufficient. The subject was in its infancy, and the weights and sections then adopted were considered the best and most economical in the opinion of the engineers of that period, who had not then obtained that experience respecting the properties of wrought iron to resist wear and tear, under circumstances similar to those under which they were required to act, which they have since acquired. It is, therefore, not surprising, that when the weights of the locomotive engines and loads, and the velocities at which they traveled, were doubled and even trebled, the rails shewed unmistakeable symptoms of being too slight, and otherwise unfitted for the heavier work passing over them.

Railroad directors and engineers are now convinced that for railroads of the usual description, rails weighing from 60 to 90 pounds per lineal yard, are more economical than those of a less weight.

With respect to the employment of unsuitable metal in the manufacture, it must be admitted by every impartial observer, that rails are for the sake of cheap production, too often made of unsuitable materials, for which, however, while railroad companies, actuated by motives of economy, refuse to pay proper prices, the manufacturers are not alone to blame. And yet it is well known to railroad engineers, that the metal employed has a most important bearing on the durability of the rail. And notwithstanding their endeavors to buy cheaply, railroad companies are unremitting in their exertions to secure good rails. It is with this object in view, that the specifications furnished by them to the rail manufacturer, are so plentifully supplied with directions for his guidance and instruction, in manufacturing this great desideratum. But in their ignorance of the changes which iron undergoes in the different processes of its manufacture, and in their anxiety to secure durable rails at low prices, they have stipulated that a certain portion of the metal used in manufacturing each bar shall be of a defined quality—superior to the rest—and have overlooked the fact, that this metal may be of a high quality, yet unfitted for the particular purpose for which it is intended, may have been manufactured with great care, and yet in practice be injurious to the durability of the rail.

To explain this inconsistancy, it is necessary to state, that iron rails of whatever section, are rolled from a number of short flat bars, placed one on the other to form a "pile," as it is technically called, of the requisite size and weight. This pile for rails of ordinary dimensions is about 3 feet long, 7 inches wide, and 9 inches high. With the present system of manufacturing, the body of the pile is built up with puddled iron, averaging about 3½ inches by ½ inch thick, and the length of the pile, while the top and bottom are each composed of an iron plate about 1 inch thick by 7 inches wide, and of a similar length with the others.

These plates are dignified with the appellation of "best iron." Their employment is usually specified in all contracts, and is therefore compulsory on the part of the manufacturer. When rolled, the metal in these plates forms portions of the head and foot of the finished rail.

By this compulsory use of best iron, railroad companies imagine that the superior qualities of the rails so manufactured are increased, and that they are consequently better calculated to withstand the wear and tear resulting from the rolling of heavy bodies at high velocities; but the very opposite is the case. Instead of increasing the resisting properties of the rail, it diminishes them, and is directly or indirectly the cause of nine-tenths of the lamination which occurs on the railroads of Europe and America.

Extraordinary as this may seem, it is no less true, that the use of this best metal has a most prejudicial effect on the duration of rails, under whatever circumstances they may be situated. On the occurrence of lamination, it will be found that the strip of metal severed from the body of the rail rarely exceeds one-third of an inch in thickness, let its breadth be what it may. By referring to the materials of which the rail is rolled, it will be observed that the plate of best iron, 1 inch thick, 7 inches wide, and 3 feet long, is, in the process of rolling, extended over the head of a rail, probably 20 or 24 feet long, and 3 inches wide, thus becoming reduced to less that one-third of an inch in thickness. It is this thin covering of best metal which it is customary to place on the heads of the rails to resist the wear and tear from the rolling of millions of tons of traffic. If soundly welded to the other layers, such a thin provision for wear may bear a few millions of tons; but if otherwise, it will probably peel off in long thin flakes before it has borne many thousands. Unfortunately for railroad companies, this last is too frequently the case.

The perfect union of the top plate to the puddled bars composing the body of the pile, is seldom accomplished. For, besides the risk which is necessarily incurred, where the welding of two plates of the same metal, but in different stages of manufacture, is involved, the top plate, from its superior dimensions and capacity for caloric, requires a proportionably longer period for elevating its temperature to the welding point. The sectional area of the top plate is 7 square inches, that of the puddled iron bars 1¾ inches, or just one-fourth of the other. Now, the time required for heating masses of metal to the same temperature throughout, when they are similarly situated, is nearly in proportion to their magnitudes; consequently, the intense heat of the balling furnace, if continued sufficiently long for thoroughly heating the large plate, must necessarily burn the small bars, but if proportioned to the capacity of these, the outside only of the large plate can be brought to the welding temperature. Hence, if soundness is obtained in the wearing surface, it is by the weakening in an equal ratio of the other portions of the bar.

In practice, however, the head and bearing surface is rarely sound. The desire of producing large quantities of rails in a limited period, induces the manufacturer to hasten the heating process, and thus, the pile is not unfrequently drawn before the smallest bars have been properly heated. By so doing, the waste of metal and consumption of fuel in the

operation, is considerably diminished, and a corresponding saving effected to the manufacturer.

The workmen, too, from being paid by contract on the quantity produced, have a direct inducement to withdraw their charges before they have been properly heated, of which it is believed they take advantage, to the loss of the purchaser.

But if exposed to the heating process for a length of time sufficient to elevate its temperature to the welding point, unless it receives that attention from the workmen which the delicacy of the operation requires, the welding of the different plates will be more or less imperfect. From the interior construction of the reverberatory furnace, extreme watchfulness is required from the attendant. The fire place being situated at the end, the flame and heated products of combustion pass over and against the piles reposing on the sand bottom of the furnace. The piles, if permitted to continue in the same position, will be quickly heated on the top and side next to the fire, while the bottom and side farthest from it will remain comparatively cool. It is the especial duty of the workman, to guard against the overheating of any part of the pile at the expense of the other portions, by exposing the different sides in succession to the fire, so that each may be brought to the desired temperature. This, by the employment of careful workmen, and a close supervision on the part of the manufacturer, is usually accomplished; but cases do occur, where one side only of the mass has been sufficiently heated, and as a necessary result, the rail manufactured from it is sound on one side, but imperfect on the other.

In support of the assertion, that the layer of best iron is seldom welded to the other portions of the rail, it may be stated, that with the view of ascertaining the proportion of rails in which it is usually accomplished, a series of experiments were made on various rails, manufactured in the usual manner, and in all respects equal to the rails now manufacturing for the European and American railroad companies.

Nearly 50 tons of rails were experimented on, at an expense exceeding $2000. The results, as will presently be seen, afford the most conclusive evidence, that the employment of best iron in the manufacture, as it is at present conducted, is attended with positive injury to the durable qualities of the rail.

The plan adopted to test the soundness of the rails, was to fix one or two iron blocks placed about two feet apart, and apply pressure to the upper side, until the bar took a permanent set of from $\frac{1}{4}$ to $\frac{1}{2}$ inch from a right line, when it was refixed in an inverted position, and the pressure applied until it took a similar set in an opposite direction. The operation was repeated four or five times, when the bar, from the violent strain to which it had been subjected, generally broke at nearly right angles with its plane. It was anticipated that before the fracture would be completed, the plates which had not been perfectly welded, would separate in distinct layers, in consequence of the violent depression acting alternately on either side of the rail, and in practice this was found to be the case.

The first lot of rails tested in this manner, consisted of 50 bars of the T, or web-footed section, weighing about 62 lbs. per yard, and manufactured in the manner previously described, viz: a number of small bars

of puddled iron capped by a large plate of best metal, and having a quantity of similar metal in the foot. They were the surplus rails of a large contract, and were of a fair average quality. When broken, of these fifty bars, *seven* exhibited every appearance of a complete union of the metal in the top plate with that in the small bars; in 27 the union was more or less perfect; but in the remaining 16, it was limited to the surface, and on applying the test to these, the head of the rail to a depth of full quarter of an inch, the wearing part about which railroad companies are so solicitous, was completely severed from the rest of the rail.

These results, showing as they do, that so large a proportion as seven-eighths of the rails manufactured under the present system are imperfect and extremely liable to laminate, were so extraordinary, that the experiments were repeated on a fresh lot of rails of the same pattern, selected indiscriminately from a heap of several hundred tons, which had been manufactured at a period anterior to that of the previous lot.

One hundred bars were experimented on in the manner previously described, and with results equally unfavorable to the durability of the rail; of the 100 tested, 13 were considered complete and free from any imperfection in the welding; 59 were partially united, generally on one side only, as if the other side had not been properly heated; while 28 were scarcely at all united.

For the purpose of ascertaining if this large proportion of defective rails, held good, also with differently shaped bars, 60 rails of the bridge pattern, weighing 70 lbs. per yard, were tested in a similar manner, and with like results. Twelve were found quite sound, 33 were more or less defective, and in 15 the union of the metals was merely superficial.

That the defective state of the manufacture is not of recent date, may be inferred from the results which were obtained by testing rails of various sections, manufactured at a period coeval with the introduction of the railway system itself. Sixty-two bars were experimented on, when it was observed that 13 were efficiently welded, 29 partially so, and 20 were defective, inasmuch, that the union of the metals was confined to the surface of the rail, and rarely extended inwards more than an eighth of an inch.

Thus, of 272 bars tested, 45, or 17 per cent., were sound and free from any defects in the welding of the top to the other plates; 148, or 54 per cent., were more or less imperfect; while in 79, equal to 29 per cent. of the whole, the top plates were but superficially united to the others.

The perfectly sound bars would probably wear for some years, the imperfect ones might, under favorable circumstances, stand considerable rolling before laminating, but the remaining quantity, which had not been welded, would not sustain any heavy traffic. It is, therefore, not surprising, that with such a large per centage of imperfect rails, lamination should extensively prevail on the majority of railroads now in use.

Objections may be urged against the mode of testing the rails, as being unlike anything occurring on railroads; and certainly, when it is considered that the bars were violently deflected until they were fractured, the objection appears to be a just one. But it is submitted, that although the test was excessive for the time which it occupied—a few hours—yet the repeated deflexions of the rails by the passage of heavily laden trains,

going at high velocities, must necessarily have a similar tendency to loosen the plates composing the rail, when it is imperfectly manufactured.

The different capacity for caloric, possessed by the different bars composing the rail pile, has been completely overlooked by railroad companies and engineers, though perfectly well known to every common blacksmith. He is well aware, that the time necessary for thoroughly heating a piece of metal, is in proportion to its magnitude, and when welding two pieces of metal of unequal dimensions, is careful to insert the largest piece first, that it may receive an accession of temperature corresponding with its dimensions before commencing with the other piece. But in manufacturing railroad bars, the case is different. Bars of iron weighing 70 lbs. and others weighing but 18 lbs. are inserted and withdrawn from the heating furnace together, although the former requires four times the quantity of caloric which is necessary for the latter. The precaution adopted by smiths, of inserting the largest piece first, is in the case of rails precluded from the altered conditions of the manufacture. In the ordinary smith's forge, the operations are limited to the forging and joining together of two pieces of wrought metal, and the extent of these, which is acted on at each heat, is short, seldom exceeding a few inches. But in manufacturing rail bars, the number of pieces to be heated and united into one compact mass at a single operation, frequently exceed twenty, a number which it would be impossible to pile one on the other with the requisite rapidity, if heated singly, to render the subsequent process of rolling complete. Before twenty separate pieces of metal could be withdrawn from a furnace, and properly arranged to form the pile, their temperature would have been reduced below the welding point, and their subsequent union by pressure under the heavy rolls, could not be effected.

The employment of the best iron in the rail pile, is attended with another disadvantage. It is generally admitted, that the metal in the wearing part of the rail should be hard and crystalline in its texture, and premising that the thin veneer of best iron has been securely united, it fulfils neither of these conditions. It is remarkable for its softness and fibrous character, manufactured from the same description of puddled iron as that employed in the body of the pile, the difference between them consists in its having visited the heating furnace, and passed between the rolls to be converted into best iron. By this extra rolling, it has increased its fibrous character, and parted with a portion of its cinder, to which it owes its welding properties. On being reheated in conjunction with the raw puddled iron, it is incapable of furnishing the quota of cinder necessary to their complete cohesion, and the weld, though apparently perfect, is incomplete, while the metal itself, from repeated rollings and reheatings, has become of an open, fibrous character, easily ruptured by pressure and concussion.

It is not easy to exaggerate the injurious effects which result to the texture of the metal from a repetition of the heating and rolling process. The fibrous character of the metal partially developed in its passage between the puddling rolls, becomes strongly marked on reheating and rolling it a second time, and highly fibrous on heating and rolling a third time. Twenty to twenty-four bars of puddled iron laid one on the other, produce when heated and rolled, the common merchant bar iron of commerce,

and this bar iron, when cut into suitable lengths, piled, heated, and rolled, produces the quality known as "best iron." Now, it is very evident, that if there be a certain number of fibres in a bar of puddled iron, the merchant bar produced from twenty or twenty-four of these bars, will contain twenty or twenty-four times the quantity of fibre, and it is equally evident, that the best iron rolled from twenty or twenty-four of these merchant bars, must contain from four hundred to five hundred and seventy-six times the number of fibres that existed in the original bar of puddled iron.

If fibre was desired in the rail bar, a repetition of the heating and rolling processes, would meet the desired results, but with an earnest desire for a non-fibrous rail, it is surprising how railroad companies should adhere to the employment of the best iron in the wearing part of the bar.

The obvious remedy for these imperfections, is a total and immediate abandonment of the objectional plate of best metal, and the substitution of its weight of puddled iron of the usual dimensions. The pile would then be built up with bars of one uniform size, and when exposed to the heat of the reverberatory furnace, each bar would receive a similar accession of temperature up to the welding point, when the whole of them could be permanently united into a solid bloom.

The puddled iron being comparatively free from fibre, is particularly adapted for the wearing part of the rail; and being obtained at a lower price than the best metal now used, the cost of manufacturing the rail would be considerably reduced, and the price to the purchasers would eventually experience similar reductions, in consequence of the strong competition which exists among mill owners.

But should there be a desire to retain the best iron in the wearing part, a number of plates of a similar size with the puddled bars, should be used instead of the large plate now employed. A perfect weld might then be obtained with the care and attention ordinarily bestowed on the operations of the heating furnace. But it is believed, that such rails will still be liable to laminate from the fibrous character of the metal, and that rails made without any admixture of such highly wrought metal, will be found most advantageous for railroad purposes.

AMERICAN PATENTS.

List of American Patents which issued from May 20, to June 10, 1851, (inclusive,) with Exemplifications by CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

24. For an *Improvement in Scarificators;* Frederick Leypoldt, Philadelphia, Pennsylvania, May 20.

Claim.—"What I claim as my invention, is the use of the said hollow pivot lever, and slide racks, combined and arranged as described, secured in their proper places by the plate and screws, and operating in connexion with the trigger and springs, substantially as herein before specified."

25. For an *Improved Compound Coupling for Hose or Pipe;* James W. Osgood, Columbus, Ohio, May 20.

Claim.—"What I claim as my invention, is the manner, if desired, of keeping the

several threads or screws always in contact, whether the coupling be formed or disconnected, for obtaining the advantages set forth by the employment of an interior box situate in an outer box, and having a loose ring or collar (or its equivalent,) on it, in combination with a washer, connecting nut, and box, formed with lips for locking the coupling; the several parts constructed, fitting, and operating together, substantially as shown and described."

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26. For an *Improvement in Smut Machines;* Nelson Pratt, Ottawa, Illinois, May 20.

Claim.—"What I claim as my invention, is, 1st, In connexion with a close case surrounding the machine, the arrangement of the fan, as herein described, in the annular space surrounding the beaters between the outer case and the fluted cylinder, and at the entrance of the pipe, through which the dust is discharged, so that currents of air will set into the machine through any cracks or openings in the same, from the room in which it is placed, by which means, the escape of pulverized dust or smut into the room is effectually prevented.

"2nd, I claim the arrangement of the air chamber, having currents of air passing through and across it, between the upper part of the beater and the space through which the descending current of air passes to the fan, for the purpose of collecting any portion of the grain accidentally thrown out of the scouring cylinder, by the blast or beaters, and returning the same, so that it may pass through the machine with the rest of the grain, in the proper direction.

"3d, I claim the conical ring or shield, for the purpose of protecting the conical screw below it, from abrasion by the descending grain, and at the same time, keeping the pores of the screw open, for a free passage of air through it into the fluted cylinder.

"4th, I claim the tube or passage for discharging the cleaned grain as set forth, and also for receiving and transmitting air to and through the tube, as described."

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27. For an *Improvement in Planing Machines;* George W. Beardslee, Buffalo, New York, May 20.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the yielding stock and cutter, when made to yield upon an axle, the centre of which is in line with the cutting edge of the knife; and this I claim, whether the socket bolt, hinged bar and nut, are or are not used for the purpose of graduating and adjusting the cutters, as herein set forth."

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28. For a *Coupling for Cords;* Lawton J. Ware, Warren, Rhode Island, May 20.

Claim.—"What I claim as my invention, is the use of half coupling, (each of similar shape and construction,) formed with lips having slots, into which projecting hooks fit, having notches serving for the bolts to enter and lock the coupling; or constructed and operating for the purposes shewn, in any manner substantially the same."

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29. For an *Improvement in India Rubber Shoes;* Horace H. Day, Jersey City, New Jersey, May 20.

"The nature of my invention is the peculiar arrangement and combination of known materials to be used in the manufacture of shoes, suitable for men, women, and children, principally as overshoes; by which means I produce shoes having new and useful qualities never before obtained, and at a less cost than any known before my invention."

Claim.—"Having described the advantages of my improvement, and the best way known to me of manufacturing the same, what I claim as my invention, is the manufacture of rubber boots and shoes without cloth, being made of separate pieces of different degrees of elasticity, and each piece having its peculiar and requisite degree. The shoe, to possess different degrees of elasticity in different parts, and uniform elasticity in each different part, and having no part without some elasticity in every direction, by the means herein described, or any other substantially the same, whereby I lessen the cost, obtain a shoe not liable to break, which can be kept clean, stretched in every direction at the same time; easier to the foot; adjustable to larger boots, and yet not rendered useless to wear over smaller; light and elegant, and retain permanently their shape."

30. For *Improvements in Reflecting Fire Places;* Robert Jobson, near Dudley, England, May 20; ante-dated December 28,1848.

Claim.—"I do not claim as my invention, a reflector made to partially surround the fire, but what I claim as my improvement, is the extension of the curved reflector entirely around the fire grate, in combination with having an opening through it, immediately under the fire grate, for the passage of the ashes, as specified.

"And in combination with the fire grate and the extension of the reflector under or below the grate, essentially as explained, I claim the ash guard, the same being applied in manner and for the purpose as set forth. And in combination with the reflector, and its sustaining frame, I claim the hinged slide, and the sustaining rollers, or their mechanical equivalent, the same being applied so as to enable the reflector to be moved outwards for the purpose of providing easy access to the chimney, for convenience of removing the ashes, whenever such may be deemed necessary."

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31. For an *Improvement in the Manufacture of Wire Strengthened Spoons, etc.;* Luther Boardman, East Haddam, Connecticut, May 20.

Claim.—"I do not claim employing a wire within the handle, as such has already been done; but what I do claim as my invention, is the manner substantially as herein shown and specified, of enclosing a wire of the required exact length within the handle, by supporting it on "points" secured to the moulds, and projecting midway or partly into the form."

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32. For an *Improvement in Steam Traps;* Charles M. Guild & John Brown, City of New York, May 20.

Claim.—"We do not claim to be the first to remove the water of condensation from steam warming or other apparatus, by means of a float and valve, or cock, but we do not know of any means by which this water of condensation is taken off through the float by a cock; therefore, what we claim as new and of our invention, is the construction and application of the float, with its mouth, opening, pipe, and barrel, on the plug, with the openings, and for the purpose of retaining the steam in warming apparatuses or in other steam pipes, and passing out the water of condensation through the float, near the bottom, substantially as described and shown."

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33. For an *Improvement in Hot Air Furnaces;* Samuel Pierce, Troy, New York, May 20.

Claim.—"What I claim as my invention, is the arrangement substantially as herein described, of the heating chambers in connexion with the furnace, when this is combined with the method substantially as described, of connecting the heating chambers with each other, with the furnace, and with the exit pipe leading to the chimney; whereby, the gaseous products of combustion are carried into and through, and made to spread out in their films in the said heating chambers, and therein retained to give out heat, without seriously impeding the draught, substantially as described."

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34. For an *Improvement in Carriage Springs;* Levi Bissell, City of New York, May 20.

Claim.—"What I claim as new, is the construction of springs, whether of wood, or part wood and part metal, or other elastic or non-elastic substances, as adapted and applicable to carriage springs, and springs for other purposes, in the manner substantially as herein described."

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35. For an *Improvement in Cast Iron Car Wheels;* Albert Hebbard, Worcester, Massachussets, May 20.

"My improved wheel has a combination of the single plate and double plates, between the hub and the rim. Besides, it has the advantage of not only a solid, but what is usually termed an undivided hub."

Claim.—"What I claim as my invention, is the above described improvement, or wheel, made with a chilled rim, either a solid hub, or one divided crosswise of its axis, two plates or discs, united in a serpentine curve at their outer peripheries, a third plate, not only made serpentine, concentrically with the hub, but curved in radial directions, as described, all cast or founded and combined together in one piece, substantially in the manner as herein before specified."

36. For an *Improved Gauging and Heading Movement for Spike Machines;* Purnel Jefferson, Bridgeton, New Jersey, May 20.

Claim.—"What I claim as my invention, is the combination of the spring gauge and catch, constructed as herein described, with the dies, and with the header for the double purpose of gauging the length of the spikes or nails, and aiding in forming the heads thereon, substantially as herein set forth."

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37. For an *Improvement in Cast Iron Car Wheels;* Isaac Van Kuran, Boston, Massachussetts, May 20.

"The nature and object of my invention is, the construction of a cast iron car wheel, which will combine strength of form with great lightness of materials, and for this purpose I cast the wheel with a solid hub, and join the said hub to the tread, by a curved plate next to the hub, which plate is strengthened by curved outside braces, then a circular tube running round the face of the wheel, and then a curved plate joined to the said tube and the tread of the wheel.

"The outside curved plate is also strengthened with outside braces, running in such a manner, that the curved braces on the inside curved plate next the hub, branch out so as to be opposite to the spaces between the outside braces."

Claim.—"Having thus explained my invention, I claim a cast iron rail road wheel, constructed with the solid hub, and the tube, the said tube being united to the hub, by a curved plate with curved projecting braces on it and connected to the tread by a curved plate with the curved braces on it; the whole being constructed, substantially as described for the purpose set forth."

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38. For an *Improvement in Ventilating Furnaces;* Henry Ruttan, Coburg, Canada West, May 20: Ante-dated, Jan. 31.

Claim.—"What I claim as my invention, is the arrangement and mode of operating the valves, in reference to the air heating space around the stove, by which the amount of air from within and without is graduated by a single movement.

"I claim, also, the arrangement of the horizontal air heating trunk, the vertical leading thereto, and its valve in combination with the air heating space."

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39. For an *Improvement in Grain Harvesters and Binders;* William Watson, Chicago, Illinois, and E. Sabine Renwick, and P. Hill Watson, Washington, District of Columbia, May 20.

Claim.—"Having thus specified our improvements in harvesting machines, what we claim as our invention, is, 1st, the method of raking and binding grain at one operation, by the mechanism herein specified, or its equivalent, substantially as herein set forth.

"2nd, We claim the arms in combination with the levers by means of which the rake teeth are alternately raised and depressed, as the rake is moved alternately in opposite directions, by endless rake chains, which move continually in the same direction.

3d, We claim the method of adapting the binding apparatus to the length of the cut grain, by varying the respective positions of the cutting and binding apparatus, substantially as herein set forth, that is to say, by moving the front of the platform with the cutting apparatus, backward or forward, or by moving the binding apparatus nearer to or farther from the front of the platform, in such manner that the sheaf may be bound near the middle of its length, whether it be long or short.

"4th, The method of binding grain by the mechanical devices herein specified, or their equivalents, acting in connexion and automatically by motion, derived from, or dependent upon, the movement of the machine to which they are attached.

"5th, We claim the cord finger operating substantially as herein set forth, by the aid of which the grain is encircled by the binding cord.

"6th, We claim the tying forceps, or the equivalent thereof, operating in connexion with mechanism, for encircling the grain with cord or band, substantially as herein set forth."

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40. For an *Improvement in Lifting Jacks;* Boliver Newbury, Catskill, New York, May 27.

"The nature of my invention consists in an improved combination of ratchets, pawls, and springs, with a lever to which a pumping or vibrating motion is given, for the purpose of throwing out or drawing in the lifting rod from or to the post, or standard of the jack."

Claim.—"What I claim as new, is the combination in the manner substantially as herein described of the pawls *f f*, the springs *o* and *i i*, and the spring lever *k*, having projections, 1 2, on each side of its fulcrum, with the lever, D, and the ratchets, *a b*, on the lifting rod, B, whereby the lifting rod may be forced out from, or drawn in to the post, or standard of the jack, according to the position of the spring lever."

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41. For an *Improvement in Lap Anvils for Shoemakers;* Henry Brunk, Albany, New York, May 27.

Claim.—"What I claim as my invention, is a metal anvil, shaped substantially as set forth and described in the within specification, with its drawings; that is, with a form adapting it to be held conveniently upon and between the knees and thighs of a workman, having a projection above the mass of metal conveniently formed into an anvil face, with a small prismatic block near the extremity of one of the arms, as a fulcrum for nippers, when the same are used in stretching or manipulating leather."

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42. For an *Improved Combination of Dies for Sheet Lead Machines;* John Robertson, Brooklyn, New York, May 27.

Claim.—"What I claim as my invention, is the adjustable interior cylindrical, and the exterior stationary conical dies, in combination and for the purposes described, irrespective of the precise manner in which they are applied, or by which the adjustment is effected."

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43. For an *Improved Vice Jaw for Saw-Filing Machinery;* George W. Putnam, Moreau, New York, May 27.

Claim.—"What I claim as my invention, is the jaws of the vice shaped to correspond to the shape of the saw teeth, and support the same, so as to prevent vibration during the operation of filing, as herein set forth, whereby a better edge is given to the tooth, the wear of the file is diminished, and the process of sharpening expedited."

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44. For an *Improvement in Alloys of Iron, Zinc, and Nickel;* Otis Boyden, Newark, New Jersey, May 27.

"The nature of my invention consists in the manufacture of wrought or malleable cast iron, either directly from the ores or from ordinary cast iron, and the application of the following chemical agents, namely, 1st, Metallic zinc, either pure or the ordinary spelter of commerce. 2d, An alloy of zinc and nickel. The application of these chemical agents consists in mixing them, that is, the zinc alone, or combined with nickel in any manner, and in proper quantities with the crude iron, or with iron, or with iron ores while in a fused state during the process of ordinary manufacture, or of any mode of manufacturing or purifying iron whatever."

Claim.—"What I claim as my invention, is the making of wrought or malleable iron either from ordinary iron, or from the ore, by the use or application of metallic zinc or spelter, and by the use of zinc and nickel combined, as hereinbefore described and set forth."

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45. For *Improvements in Machinery for Hardening and Straightening Saws, &c.;* Henry Waterman, Williamsburg, New York, May 27.

"When saw plates are hardened in the usual way, they come out warped and irregular, and with a want of equal density, the steel wanting that compactness so valuable in cutting tools, and which is never effected when the plates come from the roller. To straighten the saw plates, and at the same time to regularly condense and harden them, is the object of my invention."

Claim.—"Having thus fully described my improvements in the method of straightening and hardening saws, &c., what I claim therein as new, is the employment of the apparatus above set forth, for straightening and hardening steel plates, for saws &c., at one operation, consisting of the fingers or cams substantially as described, which support the article to be straightened, compressed, and hardened, combined with, and griped by the drop, in the manner and for the purpose above specified."

46. For an *Improvement in Seed Planters;* Jacob Barnhill, Circleville, Ohio, May 27.

"The nature of my invention consists in the mode by which the seed are made to issue from the lower box and are discharged. This is accomplished by means of a series of four or more conical cups attached to segmental rods working through leather in the bottom of the box, and extending from levers upon a horizontal shaft under the seed box; these cups are made of any capacity, corresponding with the quantity or kind of seed to be sown, and are alternately raised and lowered in the inside of the lower box, by means of levers operated upon by eccentrics and rods, hereafter more fully described."

Claim.—"Having thus fully described the nature, construction, and operation of my seed drill, what I claim therein as new, is the conical cups attached to segmental rods, extending from levers working on a horizontal shaft raised and lowered by the eccentrics and rods substantially as described, operating in the manner and for the purpose herein fully set forth and represented."

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47. For an *Improvement in Portable Swings;* Enoch S. Farson, Philadelphia, Pennsylvania, May 27.

Claim.—"Having thus fully described the construction and operation of my improvement in portable swings, what I claim therein as new, is the suspension of a swing to the hinged frame, supported or strengthened by the adjustable brace C, substantially as herein set forth."

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48. For an *Improvement in Carriages;* George B. Durkee, Alden, New York, May 27.

"The nature of my invention consists in forming the sides of the box of the carriage of a series of springs of wood or other material, confining the ends of the said springs or rods at the corners of the box, and also attaching them to each other, in the centre of the said sides, the springs being generally, (but not necessarily,) placed one above the other, producing, when the carriage is sprung by persons upon the seat, a curved tray shaped box, (the curve downward,) which shall comprise cheapness, lightness, and elasticity, with beauty and strength."

Claim.—"What I claim as my invention, is, making the sides of the bodies or boxes of carriages of a series of springs, slats, or bars, when the same are constructed and operate substantially as herein set forth and described."

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49. For an *Improvement in Omnibus Steps;* W. H. Hoyt, New York City, May 27.

"The nature of my invention consists in having a rear portion of the body of an omnibus project downwards sufficiently to form a step, said step being covered by the door when closed; by this arrangement the accidents daily occurring in consequence of persons standing upon the steps of omnibuses as at present constructed, are entirely prevented."

Claim.—"What I claim as new is, the manner of constructing the step as described, viz: by having a portion of the body of the omnibus projecting downwards a suitable distance, the bottom of said projection forming the step and so arranged as to be perfectly covered and protected by the door when closed, substantially as described."

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50. For an *Improvement in Carriages;* James C. Spencer, Phelps, New York, May 27.

"The nature of my invention consists in forming the body of the carriage of two separate parts, and uniting them by side pieces, or any other suitable way, in such a manner as to form a joint at about the centre of the body; the front part of the body projects some distance over the back part, and is somewhat elevated, so as to form the seat, and to allow a spring to be placed under it, resting upon the back part underneath; the front and back parts are directly attached to the axles by body loops; the body is allowed to vibrate, and act upon the spring by means of the joint. By this arrangement, the construction of a carriage is simplified to a considerable extent, and can consequently be built at a much less cost, while, at the same time, it is equally as good, both for ease and durability, as the ordinary ones in use."

Claim.—"What I claim as my invention, is the manner of construction as described, viz: forming the body of two separate parts, united by a joint, which allows the body to vibrate and act upon a single spring, and also admits of a direct attachment of the body to the axles, substantially as set forth."

51. For an *Improvement in Excluding Dust from Railroad Cars;* Edward Hamilton, Bridgeport, Connecticut, Assignor to Nelson Goodyear, City of New York, May 27.

"The nature of my invention consists in providing each window of a railroad car, with vertical blinds or screens on the outside, extending the whole length of the window, to stand open in the direction in which the car is moving at an angle of about forty-five degrees with the sides of the car, by means of which a current of air is created from the inside of the car outward, thereby preventing the entrance of dust, cinders, smoke, &c., into the same."

Claim.—"What I claim as my invention, is the application of vertical blinds, shutters, or screens, on the outside of railroad cars, employing the same to prevent the entrance of dust, smoke, cinders &c., into the windows of the cars, as herein described."

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52. For *Improvements in Hemp Brakes;* Paris M. Walker, Marshall, Missouri, May 27.

Claim.—"What I claim as my invention, is the combining a sufficient number of slats to break the full length of the hemp at once, in combination with the manner of feeding, substantially as set forth."

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53. For an *Improvement in Self-weighing Machines for Grain;* William Biddle, Lafayette, Indiana, May 27.

"The nature of my improvements consists in the arrangement and combination of certain mechanical devices, by which the descent of a hopper, suspended to the ends of two arms, projecting from either extremity of a horizontal transverse shaft, shall simultaneously open a trap door in the bottom thereof, and close a hinge door attached to a receiving hopper, by the descent of a vertical rod, attached to the right side of the frame, and thus cut off the discharge of the grain therefrom, until the contents shall have been discharged from the suspended hopper, when said suspended hopper is made to rise by the action of a spring attached to an arm of the horizontal transverse shaft—and the receiving hopper made to tilt frontward in the arc of a circle by the weight of the grain therein, and close the trap door of the suspended hopper, by the descent of a vertical bar or rod attached to the left side of the frame, and simultaneously open the hinged door of the receiving hopper, when the grain will again descend to the suspended hopper, and the receiving hopper made to turn rearward by a weight, so that on the descent of the suspended hopper, the gauge plate shall close the hinged door of the receiving hopper, and so on, the operation being continuous, and the exact quantity of grain indicated by every descending movement of the suspended hopper."

Claim.—"Having thus described my self-weighing machine for grain, and shown the operation of the same, I desire that it shall be understood, that I do not claim a self-weighing machine, operated by the weight of the grain, so as to form an automatic weighing machine, by which, with the aid of a register or index, the amount weighed is ascertained. Nor do I claim opening a gate or door in the bottom of a receiving hopper by the descent of a steelyard, simultaneously with the discharge of the grain from a rotating hopper. But what I do claim as new, and of my own invention, is, the employment of the metallic plate C, or its equivalent, attached to the receiving hopper B, and made to rise and fall by the action of said hopper, and a gauge Q′, in such a manner that on the *descent* of a suspended hopper F, the gauge plate Q, connected therewith, will disengage a catch plate (*f*) from the right end of the metallic plate C, and permit the latter to fall, and cut off the discharge of the grain—and simultaneously therewith open a trap door H, in the bottom of the suspended hopper—and on the *ascent* of the same, the receiving hopper B, will be made to tilt frontward by the weight of the grain, so as again to raise the plate C, and open the hinged door D, of the said plate C, simultaneously with the closing of the trap-door, as fully described and represented.

"I also claim the employment of the gauge plate Q′, when combined with the lower or discharging hopper F, for the purpose of determining the quantity of grain to be weighed by limiting the descending movement of the suspended hopper F, and consequently gauging the action of the projection Q^2 on said gauge plate Q′, to actuate the plate C, to cut off the discharge of the grain from the receiving hopper.

"I also claim the employment of the vertical pendant rods P R, confined to either side of the frame, when combined with a suspended hopper F, provided with a trap door H, for the purpose of opening and closing said trap door, by their descent alternately; said

vertical pendant rods P R, being respectively actuated by the descent of the metallic plate C, to disengage the spring catch *t*, from the rod P, to open the trap door, and by the tilting frontward of the receiving hopper B, to disengage the spring bar O, from the vertical rod R, and allow its descent to close the trap door H, as set forth in the specification and shown in the drawings."

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51. For an *Improvement in Bran Dusters;* William A. McFarlan and Thomas C. Carpenter, Wilmington, Delaware, May 27.

"Our improvements consist of a combination of devices, by whose operation the bran entering the machine is thoroughly rubbed and scoured, and is equally distributed to a bolting apparatus beneath, by whose action the fine flour and bran are separated."

Claim.—"What we claim as our invention, is the combination of the scouring, beating, and distributing brush, with the perforated guard plate surrounding it, whereby the bran to be dressed is more equally distributed and fed to the bolt, than has been done by devices heretofore in use for the purpose."

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55. For an *Improvement in Planing Machines;* Nelson Barlow, St. Louis, Missouri, May 27.

Claim.—"Having thus fullyd escribed my improved machine for planing, tonguing, and grooving planks, &c., what I claim therein as my invention, is, 1st. The jointing or hinging of the plane stock supporting frame E J *f f*, or its equivalent, at one end, and giving it an elastic bearing at its opposite end, substantially as herein set forth; whether the said plane stock supporting frame be used in connexion with individually vibrating plane stocks, or with other descriptions of plane stocks, or planing knives, or cutters, for the purpose of reducing or planing planks or boards upon their sides or edges.

"2nd, I claim the combination of the supporting frame containing the adjustable plane stocks, H H, with the self-adjusting supporting frame containing the plane stocks, G G, by which the inner or under surfaces of the plane stocks G G, are made to form a self-adjusting bed on one side of a plank, whilst the knives in the stocks, H H, are operating upon and facing the opposite side of the same, and by which the inner or under surfaces of the plane stocks H H, are made to form an unyielding bed on one side of a plank, whilst the knives in the plane stocks, G G, are operating upon and reducing its opposite side; and by which a plank can be faced on one side and reduced and faced upon its opposite side at simultaneous operations, substantially as herein set forth.

"3rd, I claim the combination of the supporting frame containing the self-adjusting plane stocks, G G, with the arbor of the roller A at its forward end, and with the supporting frame containing the plane stocks H H at its rear end, for the purpose, in the first place, of so guiding the transversely reciprocating movements of the said plane stock supporting frames, as to keep the inner sides of the respective series of plane stocks contained therein, parallel with each other, and parallel with the surfaces of the pairs of rollers A A′, and B B′; and in the second place, for the purpose of enabling the supporting frame containing the self-adjusting plane stocks G G, to be detached from the supporting frame containing the adjustable plane stocks H H, and be swung outwards upon the shaft of the roller A, to afford free access to the inner sides of the plane stocks in both the said plane stock supporting frames, substantially as herein set forth.

"4th, I claim the combination of the rollers *d*. *d*, with the plane stocks G, G, when they are so arranged that the roller in one plane stock, will form a rotating and self-adjusting mouth piece to the planing knife that succeeds it, and at the same time form a bed on one side of a plank for a planing knife acting upon its opposite side, substantially as herein set forth.

"5th, I claim the giving to straight edged planing or reducing knives or cutters, that are arranged athwart the surfaces of the boards or planks operated upon, a transversely reciprocating movement, whilst a continuous longitudinal movement is imparted to the said boards or planks.

"6th, I claim the manner of producing a uniform elastic pressure upon the upper and lower bearing boxes of the arbors of the pressure rollers A, B, C, viz: by means of pairs of screws, *k*, *k*, arranged as herein described, and having threads inclining at angles of about thirty degrees with their axes, which are banded together and operated upon by a weight (N,) substantially as herein set forth.

"7th, I claim the within described improved stock that receives the tonguing, cutters r, r,

and *r r*, composed of the central governing plate S, combined with the projections O, O, on the side plate Q, and the projections O″ O″, on the side plate R, substantially as herein set forth.

"8th, I also claim the manner of combining the stationary cutters *v*, *v*, with the governing centre plate S, by means of the inclined projections O, O″, on the sides of the said plate, the flaring notches in the plate and the gibs *p*, *p*, having lugs at each extremity placed in the said flaring notches, and acting upon the edges and front sides of the said cutters *v*, *v*, substantially as herein set forth."

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56. For *Improvements in Breech Loading Fire Arms;* Edward Maynard, Washington, District of Columbia, May 27.

"My invention relates to that class of fire arms which are loaded at the breech of the barrel, and consists of several distinct parts which are not necessarily used in connexion, but which, when so used, unite in forming a breech loading fire arm, containing certain valuable qualities not heretofore embodied in such an implement.

"The first part of my invention consists in combining with a musket or other fire arm, whose barrel is disconnected from its breech, and is pivoted to the stock at some point intermediate between its butt and its muzzle, a lever beneath the stock, by means of which the barrel is turned upon its pivot to raise and to depress its butt, which lever also locks the barrel to its breech when the butt is depressed, and unlocks it therefrom to allow the butt to be raised.

"The second part of my invention consists in combining with the improvement above specified, a piston breech pin, which by the movement of the lever in depressing the butt of the barrel and locking it in place, is made to move the cartridge forward in the barrel and to close the opening at the butt, which also by the movement of the same lever in unlocking the barrel, is made to open the butt, before the latter rises under the action of the lever. The remaining parts of my invention relate to the construction and arrangement of the several parts of fire arms, and are designed to add to their efficiency, while they at the same time enable me to alter and modify fire arms already constructed, and particularly the United States Government Musket, in such manner as to embody the improvements above specified with an increase in strength and durability."

Claim.—"What I claim as my invention in that class of breech-loading fire arms in which the barrel is disconnected from the breech and is pivoted at some point intermediate between its butt and its muzzle to the stock, is a lever beneath the stock, by means of which the barrel is turned upon its pivot to raise and to depress its butt, and is locked to its breech when the butt is depressed, and is unlocked therefrom to allow the butt to be raised, the several members of the implement being arranged and operating substantially as herein set forth.

"In combination with the above claimed device, I claim a piston breech pin, which by the movement of the lever to depress the butt of the barrel and to lock it in place, is made to move the cartridge forward in the barrel and to close the butt thereof, and which by the movement of the lever to unlock and raise the barrel, is made to unclose or open the butt of the barrel before the latter rises under the action of the lever.

"I likewise claim the sliding bolt constructed with slot and hook or their equivalents, and arranged as herein set forth, in combination with a lever handle for the purpose of imparting motion to the piston breech pin from the lever beneath."

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57. For an *Improvement in Boot Crimps;* Nathan Dawes and Higgins Harrison, Little York, New Jersey, May 27; anté-dated January, 31, 1851.

"The nature of our invention consists in so constructing and arranging the crimping plates upon a spring frame, that they will adjust themselves to any thickness of leather, and be capable of receiving any desired pressure that may be put upon them in the direction in which the creases are driven, as the tree which contains the leather is forced through said crimping plates."

Claim.—"Having thus fully described our invention, what we claim therein as new is, the combination of the spring frame crimping plates and boot tree with the adjustable side springs for the purpose of crimping boot fronts, and adjusting the pressure of the crimping plates to the particular point in which the creases have a tendency to run, the whole being arranged in the manner herein described and represented, or in any other manner essentially the same."

RE-ISSUES FOR MAY, 1851.

1. For an *Improvement in the Machinery for Manufacturing Felt Cloths;* J. B. Hyde, Assignee of Thomas R. Williams, Administrator, City of New York, patented December 14, 1840; re-issued May 6, 1851.

Claim.—"What is claimed as the invention of the said Thomas Robinson Williams, is the method, substantially as described, of forming the bat by the combined use of two endless aprons which receives the sliver from the doffer, or a carding engine, or otherwise, between them, and from the bat on one of the belts, whilst the other acts as a support, substantially as described."

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2. For an *Improvement in the Machinery for Manufacturing Felt Cloths;* J. B. Hyde, Assignee of Thomas R. Williams, Administrator, City of New York, patented December 14, 1840; re-issued May 6, 1851.

Claim.—"What is claimed as the invention of the said Thomas Robinson Williams, is, "1st, The method substantially as described, of hardening the bat, by passing the same, between two series or tiers of rollers, covered with cloth, or otherwise, and arranged over each other, the one series being provided with a reciprocating endwise motion, for the purpose of felting the bat; and the other series with a progressive rotary motion, for the purpose of feeding the bat through, with or without the use of a trough containing hot water and soap suds, or other matter, substantially as described."

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3. For an *Improvement in Cut Off, and Working the Valves of Steam Engines;* George H. Corliss, Providence, Rhode Island, patented March 10, 1849; re-issued May 13, 1851.

Claim.—"What I claim as my invention is, first, the method substantially as described of operating the slide valves of steam engines, by connecting the valves that govern the ports at opposite ends of the cylinder with separate arms of the rock shaft, or the mechanical equivalents thereof, so that from the motion thereof, the valve that keeps its port or ports closed shall move over a less space, while its port or ports is closed, than the one that is opening or closing its port or ports and vice versa, while at the same time, the two arms by which they are operated have the same range of motion as described, whereby I am enabled to save much of the power heretofore required to work the slide valves of steam engines, and by which also, I am enabled to give a greater range of motion to the valves at the periods of opening and closing the ports to facilitate the induction and eduction of steam as specified.

"And lastly, I claim the method of regulating the motion of steam engines by means of the regulator, by combining the said regulator with the catches that liberate the steam valves by means of movable cams or stops, substantially as described."

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4. For an *Improvement in Door Locks;* Calvin Adams, Pittsburgh, Pennsylvania, Assignee of John P. Sherwood, Sandy Hill, New York, patented Dec. 17, 1842; re-issued May 13, 1851.

Claim.—"What I claim as my invention, is, making the cases in which the movements of locks and latches for doors are contained double faced, or so finished that either side may be used for the outside, in order that the same lock or cased fastening, may answer for a right or left hand door, substantially as described.

"I also claim the peculiar construction and double action (upon an inclined and horizontal track or way) of the locking car B as herein before described, and the combination of the locking car B, and safety cars $g\,g^2$ with one another, and with the connecting or vibrating bar and bolt A, as within described, so as to fasten the bolt c securely, and prevent its being picked."

---

5. For an *Improvement in the Jacquard Machinery for Weaving all kinds of Figured Cloth;* Alexander Calderhead, Philadelphia, Pennsylvania, February 3, 1841; re-issued May 13, 1851.

Claim.—"Having thus described my improvements in looms, and pointed out their application to looms for weaving carpets and other figured fabrics, what I claim therein as

new, is, 1st, in connexion with looms for weaving figured fabrics, depressing the suspension board, or its equivalent, while the corresponding pattern card acting as a trap-board or its equivalent, is elevated, substantially as described.

"2nd, I claim working the card prism by mechanism connected with the loom, and whilst the boards or their equivalents for working the harness, are not opening and closing the shed, substantially as described."

DESIGNS FOR MAY, 1851.

1. For a *Design for Stove Doors and Panels;* Micajah C. Burleigh, Somersworth, New Hampshire, May 13.

Claim.—"What I claim as my invention is, the general arrangement and configuration of the ornaments and mouldings substantially as herein shown."

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2. For a *Design for Floor Oil Cloth;* James Hutchinson, Troy, New York, Assigned to Deborah A. E. and Nathaniel Powers, of Lansingburgh, New York, May 13.

Claim.—"What is claimed as my invention, is the arrangement of ornamental figures, forming a design for floor oil cloths, as shown in the aforesaid drawing."

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3. For a *Design for Clock Frames;* Nathaniel A. Batchelor, City of New York, May 13.

Claim.—"What I claim as my production, is the combination of figures, placed in the manner described, so as to form the front of a clock frame or case."

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4. For a *Design for Stoves;* James Wugar, David Pratt, and Volney Richmond, Troy, New York, May 20.

Claim.—"Having thus fully described our improvement and design, what we claim therein as new, is the foregoing described form and configuration of the plates, forming an ornamental design for a stove, as represented and illustrated by the drawings."

---

5. For a *Design for Bedsteads;* Pelatiah M. Hutton, Troy, New York, May 20.

Claim.—"What I claim as my invention, is the designs and ornaments upon the parts A, B, C and D, combined as in the drawing hereto annexed."

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6. For a *Design for Stoves;* William L. Hathaway, of Dighton, Massachussetts, May 27.

Claim.—"What I claim as my production, is the new design, consisting of the several ornamental configurations and mouldings herein above described and represented in the drawings, for the side and front plates of a cooking stove."

---

7. For a *Design for Stoves;* N. P. Richardson, of Portland, Maine, May 27.

Claim.—"What I claim as my production, is the design, consisting of the several mouldings, leaf work, and scrolls, herein above described and represented in the drawings, for the front, side, and back plates of a cooking stove."

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8. For a *Design for Stoves;* Ezra Ripley, of Troy, New York, Assigned, to Stafford & Co., of Troy, New York, May 27.

Claim.—"What I claim, is the design and configuration of ornamental stove plates substantially the same as described and represented."

JUNE.

1. For an *Improved Self-adjusting and Locking Switch for Railroads;* John C. Past, White Haven, Pennsylvania, June 3.

"The nature of my invention consists in providing certain counterpoise weights, or counterbalances (or their equivalent), upon the rock shafts on which the movable rails or

treadles act, in combination with toggle levers, arranged with the other parts of the contrivance as hereinafter described, so that a secure lock to the switch, when moved into the desired position, is established and maintained, thereby rendering it not liable to be displaced by the oscillation or jarring of the cars; and a switch is produced which can be operated or shifted with certainty, by the weight of the cars."

Claim.—"Having thus fully described this form of self-adjusting railroad switch, what I claim as my invention, is the combination of the counterpoise weights, or their equivalents, with the toggle levers and stops, substantially as described, operating in the manner and for the purpose herein substantially set forth and made known."

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2. For an *Improvement in Comb-cutting Machines;* Horace S. Cook, Assigned to H. S. Cook and Seneca Colburn, Leominster, Massachusetts, June 3.

Claim.—"I do not claim the invention of a single chisel, made to operate by successive blows or cuts, each of which is in advance of another, and so as to create a series of cuts through a plate of horn or shell, such as will separate such plate into two combs, without what is termed a bottoming; that is to say, with the roots of the teeth of each of the said combs in a *straight* line, and not in a *curved* line, as they are when made with the 'bottoming.' Nor do I claim a die so made of stationary chisels or cutters (that is to say, those which are immovable with respect to one another), and for the purpose of enabling a person, by pressure of the *whole series* of cutters at once, against a plate of horn or shell, to separate it into two combs, either with or without a bottoming; but what I do claim as my improvement in comb-cutting machinery, the same consisting in making the cutters to operate or move separately and independently of each other, and in regular succession, in combination with making them of different and the required lengths, so as to produce the separation of two combs from a comb plate, substantially in the manner, and with the bottoming to their teeth, as herein before specified."

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3. For an *Improvement in Hand Machines for Spinning Wool;* Margaret Hulings, Randolph county, Indiana, June 3.

Claim.—"What I claim as my invention, is the clamp, the inclined planes, the lifter, the adjustable stop, the trip, the hand and ratchet, with the hand and ratchet combined and arranged as set forth and described, or any analogous device, for the purpose of spinning wool."

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4. For an *Improved Arrangement of Machinery for Actuating the Crank Indicator;* Samuel B. Hutchins, Oswegatchie, New York, June 3.

Claim.—"What I claim as my invention, is the arrangement of bevil wheels and their shafts, herein represented and described, the first in the series being actuated by a motion derived from the eccentric, by means of a crank and pin, and the last giving motion to the indicator hand; the whole being constructed in the manner and for the purposes herein set forth."

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5. For an *Improvement in Seed Distributors of Seed Planters;* David and Herman Wolf, Lebanon, Pennsylvania, June 3.

Claim.—"Having thus described our improvements on the machine for planting corn and other grain, what we claim therein as new, is, in combination with the notched transverse bar, the employment of the jointed cleavers projecting from the recesses of said bar into the apertures of slide bars T, for preventing the choking of the apertures."

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6. For an *Improvement in Collars for Harness;* Joseph W. Briggs, Cleveland, Ohio, June 3.

"The nature of my invention consists in constructing a self-adjusting draught collar, so arranged as to dispense with the cumbrous harness and collars now in use, and at the same time securing the same amount of strength and durability, causing the horse or other draught animals to draw a light or heavy load with more ease and facility than with other forms of collars now in use."

Claim.—"I do not claim, generally, the hame in one piece, with pads of limited length; but what I do claim as my invention, is, the U shaped metallic breast plate, suitably padded, and made to fit around the neck of the horse; the same being so limited in length, as not to reach the shoulder blades of the animal, and being suspended from the neck by a neck strap."

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7. For an *Improvement in Processes for Treating Vegetable Fibre;* Peter Claussen, Great Charlotte street, Blackfriars, England, June 3; anté-dated August 16, 1850.

Claim.—"What I claim as my invention and discovery, is, 1st, The preparation of vegetable fibre, capable of being spun or felted, by submitting the plant from which the fibre is to be derived, to the action of caustic soda, or other solutions of like properties, and then to that of sulphuric or sulphurous acid, in the manner set forth, whereby the gummy, glutinous, and other matters which connect the fibre with the woody portion of the plant, are dissolved and discharged; and at the same time effecting the discharge of the oleaginous and other coloring matters contained within the woody portions, or straw, without staining the fibre, as more fully described herein.

"2d, I claim splitting the fibres of vegetable matter, in preparing them for spinning, by the generation and liberation of carbonic acid or other gas, within the cellular portions of said fibres, in the manner described, or in any other manner by which gas may be generated and liberated, for the purpose set forth."

---

8. For an *Improved Sash Stopper;* Joseph Osborn, Weymouth, Massachusetts, June 3.

"The nature of my invention consists in so arranging and adjusting a friction plate and spring, that the plate shall present two or three times as much frictional resistance to the motion of a sash downward, as to its motion upward."

Claim.—"What I claim as my invention, is arranging a sash stopper, composed of a friction plate, bolt, and helical spring, with the friction plate parallel to the side of the sash, and the bolt rising obliquely upward therefrom, in the manner herein set forth, so that the upward motion of the sash will relieve the same from the frictional resistance of the friction plate, by counteracting the force of said spring; and that the downward motion or tendency of the sash will augment the frictional resistance of said friction plate, by aiding the force of said spring."

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9. For an *Improvement in Horse Powers;* Cyrus Avery, Tunkhannock, Pennsylvania, June 3.

Claim.—"What I claim as my invention, is, 1st, The employment of rollers mounted or hung on the main shaft and lower guide shaft, in combination with the flanches on the wheels to retain said wheels upon their axles, when passing from one platform to the other, and to check their revolution as described."

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10. For an *Improvement in Machines for Expressing Cane Juice;* Henry Bessemer, Baxter House, &c., Middlesex county, England, June 3; anté-dated December 31, 1850.

Claim.—"What I claim as of my own invention, is, 1st, The extraction of the juice from cane, by submitting the stalks of the same in perforated tubes or other vessels, constructed on the principle described herein, to a continuous pressure, in the manner set forth, whereby time is afforded for the juice to flow from the cellular tissues, and re-absorption into the exhausted cane is avoided.

"2d, The perforated compressing tubes having either a straight or a tapering bore.

"3d, The combination of the pistons with the perforated tubes and hoppers, whereby the operations of regulating the feed, cutting the canes into equal lengths, pressing and discharging the same, are effected substantially as herein set forth."

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11. For an *Improvement in the Gearing of a Seed Planter;* Marshall J. Hunt, Rising Sun, Maryland, June 3.

Claim.—"Having thus fully described my invention, what I claim therein as new, is the combination and arrangement of the double bolt, with its slotted arm, rock shaft with its arms and pitman, for the double purpose of giving motion to the feeding apparatus, and

also regulating the quantity of seed to be sown, when said pitman is operated by a long crank, upon which it travels, as herein fully shown and represented."

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12. For an *Improvement in Revolving Frames for Drying Fruits and other Articles;* J. C. Dickey, Washington, District of Columbia, June 3.

Claim.—"What I claim as my invention, in the above described portable frame, is the centre, with three or more arms, to support a cord, netting, or cloth, for the purpose of exposing cloths, clothes, glue, fruits, seeds, &c., with facility, to be dried; so constructed that the arms may be raised up and brought together, to expedite the collection of the articles dried, and so that it may be conveniently removed when not in use, substantially as described.

"I do not intend to limit my invention to the precise form of construction described, but to vary it, to suit the circumstances in which it is to be used, while I accomplish the desired object by means substantially the same."

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13. For an *Improvement in Ornamenting Baked Earthen Wares;* Ralph B. Beech, Kensington, Pennsylvania, June 3.

Claim.—"I do not intend herein to claim the general application of oil painting to china or earthenware, but what I do claim as my invention, is, 1st, The application of coloring matter, mixed with varnish or its equivalent, to the surface of baked earthenware, for the purpose of giving to such ware a surface of sufficient body and of sufficient brilliancy for ornamental purposes, thus obviating the necessity of the glazing process, substantially as herein described.

"2d, The inlaying of pearls, gems, &c., on china and baked earthenware, for ornamental purposes, substantially as herein above described.

"3d. The peculiar cement and process, by which I affix pearls and gems to the china or baked earthenware."

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14. For an *Improvement in Carving Machines;* Lewis S. Chichester, Williamsburgh, New York, June 3.

Claim.—"What I claim as my invention, is the use of the pendent lever, suspended from a ball and socket joint, in combination with a horizontal table, for the pattern and block; the said table being affixed to the end of the pendent lever, by a ball and socket joint, the whole being arranged, with respect to the tracer and cutter, substantially in the manner and for the purpose described.

"I also claim preventing the pendent lever from changing its centre of motion, or from rotating on its own axis, or on any line passing through the centre of its motion, by the use of the bent arms working in balls in spherical sockets, substantially as described.

"I also claim combining with the pendent lever, two or more tables, substantially in the manner described, or in any other substantially the same, and arranged each with a tracer and cutter, respectively, in order that large carvings may be obtained from a small pattern, or vice versa, or both at the same time and with the same machine, substantially as described."

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15. For an *Improvement in Balanced Rudder;* Charles F. Brown, Warren, Rhode Island, June 10.

"My invention consists in the employment of two rudders, hung at a distance apart upon the same post, on each side; each of the two being at the same distance from the post, and with the surfaces of the one parallel, or nearly so, to the surfaces of the other."

Claim.—"What I claim as my invention, is, the employment, for the purpose of steering ships and other vessels in water, of two rudders hung upon and at equal distances from the same centre of motion, and with their surfaces parallel, or nearly so, with each other, in such manner that the same resistance is offered to each by the vessel's motion through the water, and both are balanced, substantially as herein described."

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16. For an *Improvement in Churns;* Davis Dutcher, Springfield, New York, June 10; anté-dated February 15, 1851.

Claim.—"Having thus fully described my invention, what I claim therein as new, is,

the combination and arrangement of the arms, H H, with their rollers I I, which are controlled by the crank, and the swinging arms, G, G, with their floats *g*, *g*, kept in proper place, both in churning, and gathering and working the butter, by the resistance of the cream, as herein described and shown, and for the purposes herein represented."

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17. For an *Improvement in Comb Cutting Machines;* Thomas W. Hill, Leominster, Massachusetts, June 10.

Claim.—"I do not claim the mere use in a die, of a clearer for forcing out of the die, the article produced thereby; but what I do claim as my invention is, the combination of the two series of lifters, and bent levers, (arranged upon the traveling carriage,) with the pressure roller, in such manner, that the continued motion of the carriage shall operate the lifters after the combs are cut, substantially as herein before described."

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18. For *Improvements in Permutation Safety Locks;* Robert Newell, City of New York, June 10; ante-dated April 15, 1851.

Claim.—"What I claim as new and of my own invention and improvement, is, 1st, the application of the lever *b* 5, and dog *b* 6, with the tusk 40, to be acted on by the talon 39, and allow the spring 38 to throw the tusk 40 into the notches on the lower part of the followers, and auxiliary followers, so as to prevent any portion of these parts, if any of the tumblers are lifted after any end shake motion has been given to the bolt, by any improper attempt to unlock it.

"2nd, The combination of the tumblers *a*, slides *b* 1, and followers *a* 9, through the tenons 18, notches 30, tongues 29, and jaws 24, to lift the slides *b* 1, and followers *a* 9, to the same extent as the tumblers *a*, are lifted by the key sections on locking the bolt, and to sustain the slides *b* 1, until the tusk 33, takes the notches 31, on the slides, and holds them, so that the bolt cannot be retracted, until all the tumblers *a*, are lifted to meet the notches 30, and allow the springs 25, levers *a o*, and auxiliary followers *a* 8, to lift and place the followers *a* 9, in the same positions as when the bolt was projected, substantially as described and shown.

"3rd, The mode described and shown, of so arranging and combining the cylinder *c* 4, by the flanches *c* 5, angles 60, tumblers *c* and *a*, and pins 47 and 49, with the detector lever D, at the part *c* 1, as that no one of the tumblers *a*, can be separately lifted without placing the part *c* 3, of the detector lever over the key hole, with the edges of the notch 55, covering the open space around the drill pin 57, by which arrangement, no movement of the cylinder *c* 4, can be made without producing the same effect, so that if powder is introduced into the cylinder *c* 4, and the cylinder is moved, with the intent of entering a blow pipe, to spread the powder on either side of the cylinder, the part *c* 3, and notch 55, instantly cover the key hole and prevents the entry of the blow pipe for such a purpose; these parts being constructed, arranged, and operating, substantially as described and shewn.

"4th, The combination of the cylinder *c* 4, block 62, and hole 63, to receive and pass out any gunpowder put in for the purpose of exploding to destroy the lock, and at the same time prevent the powder from reaching any other part of the interior of the lock.

"5th, The application of the safety valve, block 64, to prevent the explosion of any gunpowder that may be confined in the cylinder *c* 4, by plugging both the key hole and the hole 63.

"6th, The mode of fitting the key hole cover *c* 3, with the notch 55, on the detector lever D, to match the neck 56 on the key shank, such means also preventing the introduction of any pick, or false instrument, after any movement has been given to the cylinder *c* 4, by the notch 55 being as small as the drill pin 57.

"7th, The application of the guard piece on the detector lever, to prevent a pick reaching the pin of the detent dog.

"8th, The application of the cam pointed piece on the detector lever to move the pin and detent dog attached, that if the key hole cover is cut or drilled off, the piece falls away, and leaves the detent dog still holding the bolt."

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19. For an *Improvement in Churns;* Ithiel S. Richardson, Boston, Massachussetts, June 10.

Claim.—"What I claim as my invention is, the combination of the rock shaft, levers,

connecting rod, and swing for the churn, for the purpose of producing the perpendicular movement of the dasher, substantially in the manner herein described, to be denominated the oscillating perpendicular dash churn."

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20. For an *Improvement in Crossing the Fibres in Forming the Bats for Felt Cloth, &c;* Alonzo C. Arnold, Norwalk, Connecticut, June 10.

"My invention relates to a new and improved mode of carrying webs or sheets of fibrous materials, and when employed in the manufacture of felt cloth, is for the purpose of carrying the weft across, and depositing it upon the warp."

Claim.—"What I claim as my invention is, 1st, The employment, for the purpose of carrying webs, sheets, or layers, of any fibrous material, of an apron of material pervious to air, having a box, in which a vacuum is produced, placed at the back, the side of the box next the apron being perforated, or otherwise rendered pervious, so that the external air rushing through the apron to fill the vacuum within the box, forces the material close to the apron and confines it there, in combination with the manner herein described, of throwing off or releasing the materials from the apron by suddenly closing the valve in the pipe communicating between the box and the apparatus for producing the vacuum, and at the same time opening the valve in the said pipe, to admit air into the box, or by any means substantially the same.

"2nd, The flap operating in the manner and for the purposes substantially as herein specified."

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21. For an *Improvement in Governors;* George H. Corliss, Providence, Rhode Island, June 10.

Claim.—"What I claim as my invention is, making the method substantially as herein specified, of steadying the movement of governors or regulators of motion, by apparatus herein described, or the equivalent thereof."

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22. For an *Improvement in Railings;* Sommers Crowell, Reading, Pennsylvania, June 10.

Claim.—"What I claim as my invention is, making the dovetailed tenons, whether to the paling or top and bottom rails, wedge shaped in the length of the railing; the taper at the opposite ends being reverse, and making the grooves in the rails or palines in the same manner, that the palings cannot slide in either direction, binding the whole firmly together, substantially in the manner described."

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23. For an *Improvement in Machines for Facing and Polishing Stone and other Substances;* Albert Eames, Springfield, Massachussetts, June 10.

Claim.—"What I claim as my invention is, the method substantially as herein described, of grinding, facing, or polishing the surface of stones and other substances, by means of a grinder, rubber, or polisher, connected and combined with a spindle, from which it derives a rotary motion by means of universal and sliding joints, substantially as described, that the said grinder, rubber, or polisher, may be carried over any and all parts of the surface to be worked, whilst its surface is self adapting as described."

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24. For an *Improvement in Governors;* William Gardner, City of New York, June 10.

"The nature of my invention relates to the production of the same effects as are now performed by the ordinary pendulum, or centrifugal governor, and consists in hanging a pulley loosely on a counter shaft, which the pulley drives by band, or gear, from the main shaft, (or its equivalent,) through the pressure of a spring, or similar contrivance, on an arm secured to the counter shaft, the spring having its fulcrum fast to the pulley, so that any tendency to acceleration or retardation of the pulley, will, by its movement of 'lead,' or otherwise, on the counter shaft, through racks and pinions, operate the usual adjusting or regulating slide."

Claim.—"What I claim as my invention is, the employment of a loose wheel or pulley A, propelled by the prime mover, and driving its shaft B, through the action of a separate elastic force, weight, or pressure, such as procured by the spring H, in combination with the several racks and pinions, (or their equivalents,) as described, for operating the adjusting or regulating slide J, substantially in the manner shown and specified, and for the purposes set forth."

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25. For an *Improvement in Carriage Springs;* Chauncey H. Guard, Brownville, New York, June 10.

Claim.—"Having thus fully described my improvements in buggies, &c., what I claim as my invention is, the connecting of the axles of wheeled vehicles, by means o curved spring perches, which are combined with the supporting springs of the vehicles, that have a greater degree of curvature than themselves, substantially in the manner and for the purpose as herein set forth."

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26. For an *Improvement in Washing Machines;* John O'Neil, Xenia, Ohio, June 10.

"The nature of my invention consists in combining with a lever, a system of triple concentrating pressure (or compressing) blocks, for the purpose of more effectually squeezing the suds out of the clothes, during the process of washing."

Claim.—"What I claim as my invention is, the triple and concentrated action of pressure blocks upon the clothes, being constructed and operated, substantially in the manner herein set forth and described."

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28. For an *Improvement in Lanterns;* Hugh and James Sangster, Buffalo, New York, June 10.

"The nature of our improvement consists in providing the lamps with two springs, each attached to its upper part, (one opposite the other,) and extending down nearly to the base of the lamp, when each forms an elbow; thence, passing under the lamp and terminating immediately below it, so as to permit the lamp to be removed from the lantern with ease and facility, by pressing horizontally upon the spring."

Claim.—"What we claim as our invention is, the mode of attaching the lamp to the lantern, by means of the springs and flanches, as herein substantially set forth."

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28. For an *Improvement in the Method of Finishing the Heads of Screws;* Thomas J. Sloan, City of New York, June 10.

Claim.—"What I claim as my invention in the method herein described, of finishing the heads, in the manufacture of wood screws, is partly shaving the head with a cutter, before nicking, and after nicking subjecting it to a second shaving operation, to complete the shaving by means of a cutter, whose edges form with each other a more acute angle than the edges of the cutter first employed, as herein specified."

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29. For an *Improvement in Centrifugal Sugar Drainers;* William Van Anden, Poughkeepsie, New York, June 10.

Claim.—"What I claim as my invention is, the contrivance for discharging, and at the same time cleansing the strainer, whilst in motion, by means of an elevator rising in a spiral groove, substantially as described; or, by an elevator rising in vertical or inclined grooves, which is essentially the same."

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30. For an *Improvement in Grain Harvesters;* Nicholas T. Allen, Ludlowville, New York, June 10.

Claim.—"Having thus fully described my invention, what I claim therein as new is, gearing the operating parts of the machine from both the wheels, in combination with the arrangement by which portions may be driven by either, so as to equalize the driving power upon each, and thus allow the machine to be much more easily guided and controlled."

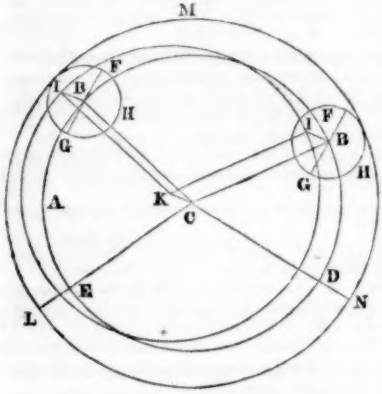
MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

Investigation of Foucault's Experiment. *By* CHARLES J. ALLEN.

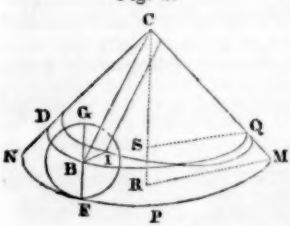
Let A B D E (Fig. 1,) be any circle, and C its centre; also let F H G be a circle, having its centre B on the circumference of the first circle. Then if the point B advance with a uniform motion along the circumference of the circle A B D E, carrying with it the circle F H G, in such manner that any diameter F G of this circle, shall preserve its parallelism, then it is evident that the circle F H G will have a retrograde rotation about its own centre, *relatively to the line joining the centres of the two circles*, and that the angular amount of this rotation during any given time, will be equal to the angle described by the radius C B in the same time; and further, if I be any point in the circle F H G, and if (I B being joined) I K, C K be drawn parallel to B C, B I, then as B advances, I B and K C continuing equal and parallel, K I and C B will also continue equal and parallel, and therefore the point I will describe a circle of which K is the centre, and K I (= C B) the radius: this circle will therefore be equal to the circle A B D E; also, since the radii K I and C B continue parallel, they describe equal angles, and the points I and B *equal arcs*, in the same time.

Fig. 1.



Now with the centre C and distance equal to the sum of the radii of the two circles, or with any distance greater than this sum, describe the circle L M N, and draw the radii C L, C N cutting the circle A B D E in D and E. Then conceive one of the sectors thus formed, as for instance N C L M, to be rolled up so that the lines C L, C N shall coincide, thus forming the cone C N M, (Fig. 2, in which the same letters refer to the same parts as in Fig. 1.) Then the similar arcs L M N and E A B D (Fig. 1) will form complete circles of the cone, viz: the circles N P M and D B Q, respectively, whose radii will be the lines M R, Q S drawn perpendicular to C R, the axis of the cone.

Fig. 2.



If now the circle F H G have the same motions as before, both along

the circumference of the circle D B Q, and about its own centre,* it is clear that the point I will trace the same line on this superficies, now that it is the surface of a cone, that it did when the same superficies was a plane; and that, consequently, the points I and B will, in any given time, describe *lines of equal length*, for it is evident that the relative position of the several lines on this superficies, *as reckoned along the superficies*, (not, however, their relative position *in space*,) must remain unchanged, provided we do not cross the line where the two edges of the sector L C N M unite. While, therefore, the circle F H G makes a complete revolution around the cone, its angular rotation about its own centre, relatively to the line drawn from this centre to the point C, will be the same as in describing the arc D B A E (Fig. 1,) but this, as shown above, is equal to the angle described by the radius B C, while B advances through the arc D B A E, that is, it is equal to the number of degrees in this arc: but this arc is equal to the circumference of the circle D B Q (Fig. 2). Hence, 360° : the number of degrees in the arc D B A E :: the circumference of the circle D B A E : the circumference of the circle D B Q :: the radius C B (= C Q, Fig. 2) : the radius Q S :: 1 : sin Q C S. Hence the number of degrees in the arc D B A E is equal to 360 × sin Q C S, which is therefore the angular relative rotation of the circle F H G, while performing a complete revolution around the cone.

Now let H = the angular revolution of the circle F H G around the cone for any given time, and x = the relative rotation of this circle about its own centre in the same time. Then, since x bears the same proportion to the rotation corresponding to a complete revolution, that H does to 360°, we have, 360° : H :: 360° × sin Q C S : x ; whence, x = H × sin Q C S.

Now let a pendulum, free to vibrate in any direction, be suspended over the centre of the circle F H G (Fig. 1), this circle having the two motions above described, and let the pendulum be made to vibrate across this circle by an impulse given it while in a vertical position. Suppose also the centre of attraction to be perpendicularly under the point C, and at such a distance that the resultant of the gravitating and centrifugal forces (and consequently the axis of vibration) shall always be perpendicular to the plane of the circle. Then it is evident that the ball of the pendulum will retain, in every part of its vibration, the orbitual motion or velocity due to the point B; and since, as has been proved above, every point in the circle F H G has this same orbitual motion, viz: that of the point B, it follows that the pendulum and the several parts of the circle F H G, have (irrespective of the vibration) *the same absolute motion*, and are therefore RELATIVELY AT REST, *except the motion due to the vibration alone.* Hence the pendulum will move with respect to this circle as if the two were *absolutely at rest*, that is, it will describe a straight line across the circle, and the same line at each suc-

* Although the circle F H G is no longer a true circle *in space*, it is a true circle as reckoned along the conical superficies; nor is this rotation, strictly speaking, a rotation *in space*, but a rotation on the surface of the cone, in such manner that any point in the circle shall preserve a uniform distance (as measured along the conical surface) from the centre B.

cessive oscillation, the plane of vibration performing, with the circle F H G, a retrograde revolution about its axis, relatively to the circle L M N, its angular relative rotation in any given time being equal to its angular orbitual motion in the same time. This result might have also been deduced directly from the fact, that the plane of vibration must, under the circumstances supposed, maintain its parallelism; but the above method has been followed as being equally applicable to this and the following case.

Now let the pendulum be suspended over the centre of the circle F H G on the surface of the cone C N M (Fig. 2), and let this circle have the motions supposed above: also let the pendulum be made to vibrate as before, the gravitating and centrifugal forces being such that the resultant of these forces shall be perpendicular to the superficies of the cone in every part thereof. Then, as in the previous case, the ball of the pendulum, having a certain orbitual velocity, will maintain this same orbitual velocity in every part of its vibration, that is, the velocity due to the point B, which is also the velocity of every and any point in the circle F H G. Hence (the circle F H G being supposed so small, compared with the cone, that the conical superficies included within it may be regarded as a plane*), we see that in this case also the pendulum and the several parts of the circle F H G will be *relatively at rest*, excepting only the vibratory motion; and consequently the plane of vibration will, as before, always intersect this circle in the same straight line, that is, *it will revolve on its axis with this circle.*†

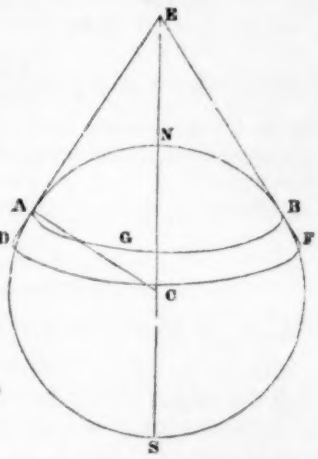
It is manifest from what has been shown above, that the system of radiating curves described by the pendulum on the circle L M N (Fig. 1), and on the surface of the cone D E F (Fig. 2), is the same as would be described if the axis of vibration, and the plane of vibration, were *fixed* in space, and the circle L M N in the former case, and the cone D E F in the latter, were to rotate about this axis with a uniform angular velocity.

* When the conical superficies included within this circle varies sensibly from a true plane, the only effect is, that the velocity of rotation of the plane of vibration is not *uniform*; the *mean* velocity, however, is not affected.

† This reasoning is not strictly correct, unless we suppose the ball of the pendulum, or, more correctly, the centre of this ball, to move in a plane parallel to the circle F H G, or in other words, unless the arc of vibration be considered a straight line, (a supposition manifestly inadmissible;) for, the higher parts of this arc being more remote from the axis of orbitual motion than the lower parts, have a greater orbitual velocity. Hence arises an irregularity in the rotation of the plane of vibration. But a little examination of this point, will show that the only effect is an *oscillatory* motion of the plane of vibration about its axis, this motion being in the *same* direction as the rotation, while the ball of the pendulum is over that half of the circle F H G which is towards the base of the cone, but in a direction *contrary* to the rotation, while the ball is over the half of F H G which is towards the apex of the cone. These motions, being equal, balance each other, and therefore the *mean* rate of rotation is not affected. Moreover, the amount of this oscillation, even when at its maximum, especially if the pendulum is a long one, is exceedingly small. This source of irregularity may therefore be entirely disregarded in the above investigation.

Now let A N B S (Fig. 3) be the earth, C its centre, N and S the poles, A any place on its surface, and A G B the circle of latitude of that place. Also let E D F be a cone touching the sphere in the circle A G B, and having its vertex at E in the prolongation N E of the axis S N. Join A C: then E A C is a right angle; and since A C E is the co-latitude of the place A, A E C is the latitude, which put = L. If now a pendulum vibrate at A, while the earth revolves on its axis S N, the case is that of a pendulum vibrating on the surface of the cone D E F, and revolving around that cone in the circle A G B, parallel to its base. If then, H = the angular rotation of the earth in a given time, and x = the corresponding angular rotation of the plane of vibration relatively to the line joining A and E (i. e. relatively to the meridian of the place), the result deduced above gives us the equation $x = H \times \sin A E G = H \times \sin L$: which is the result obtained by the French mathematicians.

Fig. 3.



It is evident that the ball of the pendulum will always present the same face towards the same points of the compass, since it has, at the commencement of the experiment, the same *virtual rotation* about the axis of vibration, as the surface of the earth beneath it. In making the experiment, therefore, it is of no advantage to suspend the wire in such manner as to turn freely in a horizontal direction.

In the foregoing investigation, the pendulum is supposed to vibrate from an impulse given it while in a vertical position: if, however, it be started at the circumference of the circle F H G, the ball having the *orbital* motion of the point from which it commenced its vibration, then instead of describing a straight line across the circle F H G, (this circle rotating in a retrograde direction, as above supposed,) it will describe an oblong curvilinear figure about the centre B, which figure will be the result of a *compound vibration* composed of two cross vibrations, one the main vibration, the other in the direction of the orbitual motion, (that is, in the direction of this motion across the circle F H G at the time of commencing the experiment,) the latter vibration being occasioned by the difference in the orbitual velocity of the starting point, and that of the centre B. The form of this curvilinear figure will evidently approach to a straight line, according as the direction of the main vibration approaches that of the orbitual motion. A short investigation founded on the well known principles of the pendulum, shows that the chord of the arc of orbitual vibration is found by the following formula, in which y = half this chord, r = radius of the circle of vibration (= half the chord of the main vibration), l = length of the pendulum (in feet), and

a = the angle contained between the meridian and the line representing the initial direction of the first vibration, viz:—

$$y = \frac{r \text{ sin. L cos. } a}{77787} \times \surd l$$

Hence when $a = 0$ $y = \frac{r \text{ sin. L}}{77787} \times \surd l$, whichis there fore the equation for the semi-minor axis of the figure described on the circle F H G, by a pendulum started from the most northern or the most southern point of that circle.

Philadelphia, 6th mo., 1851.

For the Journal of the Franklin Institute.

Remarks on Nystrom's Screw Propeller. By B. F. Isherwood, *Chief Engineer, U. S. N.*

As the subject of the Screw Propeller is, at the present time, one of the most interesting in mechanics, and has not yet, to our knowledge, been satisfactorily treated, we give with great pleasure, Mr. Isherwood's criticisms on Nystrom's Screw, published in our May Number—omitting, as is our custom, those passages in which the author has thought proper to use personal and insulting language, for which, we repeat, there is no room in our Journal.—Ed.

I have read in the May number of the Journal, a "Description of a Screw Propeller, patented by John William Nystrom," March 19, 1850, which, as it has found a place in the Journal, appears worthy of a few remarks.

The peculiarity of Mr. Nystrom's Screw, consists in the formation of the helicoidal surface by a *curved generatrix*, instead of a *straight generatrix*, as usually employed.

It may be necessary to define what is meant by a generatrix. Let any right line whatever be taken and called the *axis of the helicoid* or screw, and let any other line curved or straight of definite length be taken, lying at any inclination to the axis, and with one extremity touching the axis; this line is the *generatrix of the helicoid* when it is moved simultaneously with a rotary speed around the axis, and a rectilineal speed along the axis.

As previously remarked, Mr. Nystrom uses a curved line for the generatrix, instead of a straight line, as usually used; and the object of using the curved generatrix, is to prevent the alleged loss of effect, caused by the centrifugal force imparted by the rotary motion of the helicoidal surface to the particles of water with which it is in contact. Before proceeding to cure an alleged evil, it may be advisable to ascertain if it exist, and to what extent.

If the helicoid had no slip, and moved through the water a distance equal to its pitch per revolution, there evidently could be no centrifugal force communicated to the water in contact with it, for as the helicoid continuously advanced, it would no sooner press any molecule of water, than the pressure on that molecule would be removed by the advance of

the helicoid. The helicoid, in this case, would be in contact with the molecule but an infinitely short time, and of course could endow it with no centrifugal motion. But if the helicoid have slip, the effect of that slip is to keep the molecule of water in contact with the helicoid for a time proportional to the slip, and, consequently, to endow it with a proportional centrifugal force. If the slip be considerable, the throwing off of the water at the periphery of the helicoid may become sensible, in consequence of that force and the property of the water to escape by the easiest road. This effect was observed in the experiments of Taurines, which were performed on *fixed* screws, not advancing rectilineally, but having only a rotary motion on the axis; by which arrangement the slip amounted to unity. The amount of centrifugal force imparted to the particles of water by the rotating helicoidal surface in contact with them was, however, very trifling, even under the most favorable condition of maximum slip; for the very effect of that slip was to discharge the water from the helicoid, the vacuity being filled by fresh water flowing in. Having thus determined the existence of a small amount of this centrifugal force, and the conditions of slip modifying it; let us inquire whether, even in the event of the amount of this force becoming considerable, there would result any loss of effect.

And, first, what would be the nature of that loss of effect, if any existed? It would be shown in the *increased slip of the screw* for the following reason. The water being thrown off radially in all directions from the axis, by the centrifugal force communicated to it by the revolving screw, there would be a vacuum about the axis, provided the centrifugal force forming the vacuum exceeded the force with which the surrounding water would flow in to fill it, and the resistance to the screw would be decreased in proportion to the extent of this vacuum; that is, the slip of the screw would be increased. *The loss of effect therefore due to this centrifugal force, would be measured by the increased slip of the screw.* But if the water flowed into the vacuum as fast as it was formed, the resistance to the screw would evidently remain the same as though there were no centrifugal force in action; and this is what actually occurs in practice. Let it then be considered the depth to which the axis of a 13 feet diameter screw (mean size) is immersed, and the consequent pressure of water about it, and then the slips found in practice, ranging from 15 to 30 per cent. for maximum, and it will be seen how enormously the effect of any centrifugal force must be exaggerated, to make it productive of a vacuum at the axis of the screw. Supposing now a centrifugal force to be given to the molecules of water in contact with the helicoidal rotating surface, of any amount less than requisite to produce a vacuum at the axis: would it be attended with loss of effect by the screw? Evidently not, for the following reasons.

With a straight generatrix touching the axis, the lateral component of the oblique surface of the screw is tangential to a cylinder, by which the screw may be supposed to be enveloped; or is at right angles to the radii of that cylinder. With a straight generatrix touching an inner cylinder, having a common axis with the screw, the lateral component is no longer at right angles to the radii of the enveloping cylinder, but either

converge to, or diverges from, the axis, as either the acute or obtuse angle is used for propulsion. In both cases the component in the direction of the axis continues the same; that is, parallel to the axis. Now, it is the component in the direction of the axis that alone propels; hence, the slips of screws of the same diameter, pitch, and length, but the one having a straight generatrix touching the axis, and the other a straight generatrix touching tangentially a cylinder having the same axis as the screw, should be the same. The only effect, then, of converging the lateral component to, or diverging it from the axis, is, to cause a flowing of water to or from the axis, proportioned to the obliquity of the lateral component to the axis, and as this component does not affect the propulsion, it is obviously of no importance what be its direction. There can be no loss of labor attending it, for as all angles are in function of form, equally efficient for propulsion, consequently, their components are equally so. The same slip, or, in other words, the same resistance, is obtained from the water, with screws of equal diameter, pitch, and length, whether they have straight, inclined, or *curved* generatrices: for the curved generatrix is obviously but a modification of the inclined generatrix; that is, it is an inclined generatrix, whose inclination momentarily changes. It is therefore governed by the same principles.

There is, however, a *practical* disadvantage and loss of labor attending the use of a curved generatrix, though none theoretically, that is, in function of form: for the friction of the helicoidal surface on the water, which in differently proportioned screws ranges from 10 to 20 per cent. of the power applied; being as the surfaces with equal speeds, and the surface of a screw of given diameter, pitch, and length, or fraction of one convolution of the thread, is greater with the curved than with the straight generatrix, because an arc of a circle is greater than its chord; it follows then, that in otherwise similar screws the greater the curvature of the generatrix, the greater the loss by friction. The only real loss of power attending the imparting of a centrifugal force to the molecules of water, is that due to their momentum, that is, will be expressed by multiplying the weight of water, to which centrifugal force is imparted by the square of the speed, with which it flies off radially from the centre. In the most favorable case of maximum slip, that is, a slip of unity, this product would be an almost insensible proportion of the total power applied.

From the foregoing, then, it will be perceived that a curved generatrix, so far from being advantageous, is positively a disadvantage; nor is it necessary to depend entirely on induction for this opinion; for it has been fully confirmed by experiment. About the year 1847, (I give the date from memory,) a series of the most complete experiments were made by Bourgois, by order of the French government, on a vast number of screws of different proportions and shape, among them the form of screw (i. e. with a curved generatrix) afterwards patented in this country by Nystrom. These experiments were made with great sagacity of method, and determined most satisfactorily the total uselessness of a curved generatrix. I give the condensed results of the experiments, which will be the first time they have appeared in an English work.

It was perfectly comprehended by Bourgois, that in order to make the influence of a curved generatrix sensible, it would be necessary that the screw have a very considerable slip; its surface during the experiments, was therefore sufficiently reduced to satisfy this condition. To fully test this influence, the screw was first tried, propelling with the convex face, then tried propelling with the concave face, and lastly tried after the flexure had been taken out of the generatrix, that is, after the generatrix had been made straight.

The results are as follows:

Time.	*Conditions.*	*Slip of Screw.*	
		per cent.	With curved generatrix.
March 4.	Strong breeze, river rough, propelling with the convex face of the screw. Mean of six experiments.	50·2	
Same day, same time.	Propelling with the concave face of the screw. Mean of six experiments.	49.3	
March 19.	Calm. Propelling with the convex face of the screw. Mean of six experiments.	44·4	
Same day, same time.	Propelling with the concave face of the screw. Mean of six experiments.	47·6	
March 20.	Calm. Propelling with the convex face of the screw. Mean of four experiments.	45·4	
Same day, same time.	Propelling with the concave face of the screw. Mean of four experiments.	48·8	
Same day, same time.	The same screw having the generatrix made straight. Mean of eight experiments, four being made on each face.	51·2	With straight generatrix.

Allowing for unavoidable errors of observation, dimensions, &c., in experiments of this nature, it will be observed, that sensibly the same result was obtained, propelling with either face of the curved generatrix and the straight generatrix, showing that the employment of a curved generatrix was at least useless, even with the exaggerated slip of 50 per cent.; 30 per cent. being the maximum in practice.

After reviewing some experiments carefully made on other screws, for the purpose of determining the effect of a curved generatrix, Bourgois remarks, which I translate as follows:

"In the second place, if we observe helicoidal surfaces with curved generatrices, or what amounts to the same thing, generated by a straight line inclined on the axis, we perceive the liquid threads do not rest on the same helicoidal thread. As the periphery of the screw is approached, the helicoidal thread inclines its propelling surface towards the axis, and the liquid thread keeping at rest in the normal plane, inclines itself slightly towards the centre; there, on the contrary and for the same reason, the liquid threads tend to remove themselves from the axis, but being endowed with less momentum than the first, there results a flowing of water towards the centre of the screw with so much the more abundance as the curvature of the generatrix is greater. This is the only notable effect resulting from the employment of a curved generatrix; and there is nothing to prove that effect favorable.

The experiments made on screws B 7 and B 8,* show, on the contrary, an increase of slip of 04·7, proving that the employment of curved generatrices directs the water towards the axis in consequence of their obliquity.

The experiments on screws ϕ_3 and ϕ_4 under similar conditions, gave sensibly the same result, either the water was pushed towards the axis, or it was deflected out towards the periphery.†

Finally, in passing from screw Ω to Ω_1, the slip increased 07·5."‡

The experiment of Sabloukoff, on a screw turned in air, and having the phenomena made visible by smoke, also corroborates the above. It was found that, after a high rotary speed had been given to the screw, the smoke being then let on at its anterior extremity, at any point *near its periphery*, was drawn towards the screw, and carried towards the other extremity. When let on at its anterior extremity, *near the axis*, the smoke coursed along parallel to the axis, without any appearance of having a circular movement, and which was the same in the first case; spreading out from the axis, which should have been the case had the rotation of the screw been able to give a *sensible* centrifugal force to the smoke.

But even supposing, (which we have seen is far from being the case,) that the centrifugal force communicated to the particles of water in contact with the propelling surface by its rotary movement, were great enough to produce so sensible a result as a vacuum at the axis of the screw equal to a diameter one-fourth the diameter of the screw, and supposing the use of a curved generatrix to wholly obviate this, or restore solid water in the place of the vacuum; even then the employment of a curved generatrix would be useless as far as the reduction of the slip of the screw is concerned, and this fact also depends on the carefully conducted experiments of Bourgois. In those experiments there were tried two screws, exactly alike, excepting that the one had a projected area at right angles to axis, of 187·86, while the other had a similar area of 182 59, the reduction being made by cutting out the surface immediately around the axis. The diameter of the screws was 15·752, and the diameter of the cut out part of the last screw was 3·938. The slip of the first was 35·2 per cent.; of the last, 32·6 per cent. Similar experiments on two other screws, differing from the above in pitch only, gave with the full screw a slip of 26·9 per cent., with the cut out screw 24·4 per cent. On these experiments Bourgois remarks, which I translate as follows:

"The difference (between the slips being little enough to be attributed to irregularities of construction or slight errors in the observations,

*Which were precisely alike, and formed with the generatrix tangent to an inner cylinder, which is virtually a curved generatrix. B 7 propelled with the obtuse or convex face, and gave a slip of 26·1 per cent. B 8 propelled with the acute or concave face, and gave a slip of 30·8 per cent., or 4·7 *per cent. more.*—B F I.

†Screws ϕ_3 and ϕ_4, were precisely alike, and formed with the generatrix tangent to an inner cylinder. Screw ϕ_3 propelled with the obtuse or convex face, and gave a slip of 32·8 per cent. Screw ϕ_4 propelled with the acute or concave face, and gave a slip of 33 per cent.—B F I.

‡Both screws being precisely alike, except that screw Ω had a straight generatrix; and gave a slip of 34·5 per cent., while screw Ω_1 had a curved generatrix, and gave a slip of 42· per cent.—B F I.

nothing can be concluded from it, except that a hollowing out, of which the diameter is equal to the fourth part of the exterior diameter of the screw, has no influence on the slip."

Believing that sufficient has been written to put this subject in a true light, there only remains to notice a few of Mr. Nystrom's statements. And first he says:

"The water between the blades is acted upon at the same moment by two forces, the one being the propulsive force resulting from the oblique action of the revolving blades, and the other being the centrifugal force generated by their rotation, the first force tending to force the water backwards *in directions parallel to the axis* of the propeller." This is erroneous, the water forced backwards by the blades of the screw is *in directions at right angles* to the surface of those blades; no fact in hydrostatics being better established than that fluids are *always* pressed in directions at right angles to the pressing surface.

Mr. Nystrom gives the slip of screw propellers for ocean steamers at 50 per cent. This is not the fact, 30 per cent. being the maximum, and any screw giving a greater slip, should be immediately (and would be) changed for another of better proportions, giving the proper slip of about 25 per cent., which gives the minimum of the losses of labor by slip and friction of the screw surface on the water.

Mr. Nystrom also recommends the employment of bands for strengthening the blades, to be applied at the *periphery* of the screw. Now the propriety of using bands at all results from the fact that the water acted upon by the blade in its lowest position, offers a greater resistance on account of its greater depth than the water acted upon by the blade in its highest position, but the blade must possess strength enough to withstand the greater resistance; if, therefore, the excess of strength which it would have when subjected to the less resistance, could be applied to it when subjected to the greater resistance, a less strength of blade would answer. In the common paddle wheel, this is effected by bands or rings uniting the extremities and intermediate points of the arms or radii bearing the paddles, and Mr. Nystrom adopts the same system for his screw propeller, without, however, recognising the important difference, that the reaction on the paddle-wheel arms is at right angles to those arms, and *directly in the line of the uniting rings*, while the same reaction on the blades of the screw being at right angles to the helicoidal surface of those blades, and that surface being oblique to the axis of the screw, and not in the same direction as in the paddle-wheel, the reaction would not be at right angles to the axis, and as the rings or bands are placed at right angles to the axis, *would not be* in the line of the bands, but oblique to them, so that the bands, instead of being subject to a strain in the direction of their length only, would be subject to an additional cross strain, and in proportion to the sines of the angle of obliquity of the blades. To resist this cross strain, the bands would have to be impracticably large; and if not made strong enough for this strain, they are useless. Furthermore, if used at all, the bands ought evidently not to be applied to the periphery of the blades, but to the centre of effort of the blades. They are, however, a totally unnecessary and worthless appendage to any submerged screw.

When the date of Bourgois' experiments are considered, so far antecedent to Nystrom's patent, it is really amazing that our patent office should have granted a patent without novelty; but as I apprehend no one will ever be found to use it, so the issuing of the patent will do no harm to any but the inventor, who suffers to the extent of the patent fees and cost of model, &c.

For the Journal of the Franklin Institute.

Sketch of the Invention of Parker's Water Wheel. By Z. PARKER.

In the year 1825, Z. G. & A. Parker, brothers, were in partnership, erecting mills in Cashocton county, Ohio, on Wills Creek, a navigable stream, much subject to "back-water." Having started a flutter-wheel saw-mill in July of that year, it was found, from freshets occurring frequently, and the known character of the stream, that the wheel would be flooded, and the mill consequently inoperative a great portion of the time.

To remedy this disadvantage in a second saw-mill in the same building, it was contemplated to build a geared re-action mill, such as were common at the time. But these mills being expensive, and hard to keep in working condition, this arrangement was not very satisfactory. In the latter part of august, Austin Parker suggested the idea of avoiding gearing, and making a wheel that would run under water, by arranging a number of small re-action wheels vertically on a horizontal shaft, to occupy the same position as the flutter-wheel. After due consideration, this suggestion was approved, and in November, a pattern for cast-iron buckets for such a wheel was made by myself, and taken to a foundry in Zanesville to be cast. The castings were got to the mill in February, 1826; and in March or April, the construction of the wheel, consisting of six (two double and two single) small re-action wheels, 28 inches diameter, was commenced. In November, the arrangement was so far completed, as to admit the application of the water, as an experiment to enable us to judge of the power and speed of the wheel. The result indicated an entire failure, the wheel only making about 80 revolutions per minute, running free, when at least 180 were expected; and it was held with a slight resistance to its motion.

In consequence of this failure, the work on the new saw-mill was suspended, and our attention turned to the erection of a flouring and grist-mill. For this, a common re-action wheel was made, which was put in operation in the fall of 1827. While at work at it, and before the gearing was attached, a small stream of water was admitted to pass through it, which was slowly turning it. The water, in consequence of the direction of its approach, fell into the wheel with a vertical or whirling motion, which was in the direction contrary to the motion of the wheel. A plank by accident fell into the penstock, and lodged in a position which changed the direction of the water, so as to cause it to enter with a circular motion, coinciding with the wheel's motion. The wheel was at once observed to start off with nearly double its previous speed. The plank was removed, when it again relaxed to its former motion; and by frequently trying the experiment with the plank in and out of the place where it

lodged, it was satisfactorily ascertained, that the wheel had nearly double the speed and power, when the water entered it revolving with it, as when in the contrary direction.

This discovery brought to light an error which had been committed, in the introduction of the water to the saw wheel, which was inadvertently made such as to cause it to enter whirling the wrong way; and the confident hope was then revived of yet making it successful. Accordingly, in the summer and fall of 1828, such alterations were made in the adductive passages as would cause the water to enter the wheel with a lively circular or helical motion, coinciding with the revolution of the wheel. On introducing the water, the success was found to be complete; and the same wheel, which with the water entering the wrong way, made only 80 revolutions per minute, now made 280, and apparently with great power. This trial was made in the latter part of October.

In November, with a view of an experiment in applying the principle more perfectly, a small re-action gig-wheel was made, (for backing the log-carriage of the same mill,) with such modifications in its form and proportions as were thought to be necessary to adapt it to the new mode of action of the water, to which the first helical sluice, in the form represented in the patent, was applied. Its speed and power were beyond our most sanguine expectations.

The saw-mill was got fully into operation in December, 1828, and such was the success, that with an aggregate orifice of 250 square inches, on a fall of 5½ feet, the new wheel would saw 3000 feet of boards in a day; while the flutter-wheel, (which was considered a good one,) with a gate of supply of more than 450 square inches, would only saw 2000 feet. The alteration of the saw-wheel, and the planning and construction of the gig-wheel, were done almost entirely by myself, and under my directions.

The "new idea" of the "draft boxes" originated with Austin Parker, then in Portage County, Ohio, early in 1833; and he made a number of experiments to satisfy himself of the practicability of the principle, and applied them imperfectly and experimentally to several mills, and was making further experiments in their application at the time of his death in October, 1834. Further investigations and experiments, and the final perfecting of this part of the invention, was done subsequently by myself.

The beautiful and interesting experiment which manifests the law of the centrifuge and equilibrium of a mass of water, or other fluid, revolving within a vertical cylinder, variously changed and repeated, so as certainly and fully to establish the truth of the deduced law, was made by me in Licking County, Ohio, in January, 1841, and a notice of it with a diagram, together with various statements, drawings, and models, relating to the invention, was sent to the Franklin Institute, in May of the same year.

An extensive set of experiments was also made at the same place in April, 1844, for the purpose of ascertaining the true value of the circular motion of the water, in its application to re-action wheels, and the superiority of the improved form of the wheel over the old; and a paper containing a tabulated statement of the results was presented to the Institute in the May or June following.

The change in the form of the orifices and curves of the wheel, from the original square issue, was done progressively by both the inventors from 1832 to 1838.

The adaptation of the improvements to great powers on high falls, has occupied much of my time during the last three years; the plan has been finished as far as it can be, without further practical experiments, for nearly a year.

A great variety of experiments were made during the progress of the invention, involving much time, expense, and thought, particularly in 1827 and 1828, for the purpose of ascertaining the most advantageous mode, and the best forms and proportions, for producing and applying the vertical motion of the water, previous to preparing the specifications and applying for the patent; and also in 1833-4-5 and 6, in studying, arranging, proportioning, and perfecting, theoretically and practically, the "drafts."

For the Journal of the Franklin Institute.

Dimensions of the Engines and Vessels of Steamers Pioneer and City of Pittsburg.

I have the pleasure of sending herewith, the dimensions of the engines and vessels of steamers Pioneer and City of Pittsburg, intended for the Liverpool trade, now building in this city. The Pioneer, from the yard of Mr. J. Bell, is a ship of easy lines, though by no means sharp. The City of Pittsburg, from the yard of Messrs. Perrine, Patterson & Stuck, has more floor and is much fuller, yet sharp at both stem and stern.

The engines of each vessel are double vertical trunk engines of the same dimensions, compact in form, and heavily built for their power. As similar engines have been before constructed, there can of course be no claim to originality, but the combination and adaptation of the various improvements which have been from time to time made upon marine engines, is justly due to Mr. Frederick Rumpf, the engineer of the establishment.

	Pioneer. Feet.	City of Pittsburg. Feet.
Length of vessel,	230	245
Width of beam,	38	38
Depth of hold to keel,	31½	33
Space occupied by engines in length of vessel,	21	21
Length of boilers, (double return drop flue),	29	30
Width of boilers,	16	11 3 in.
Height of "	10	12
Number of "	two.	three.
Diameter of steam cylinders,	85½ in.	85½ in.
" " trunk,	39 "	39 "
Length of stroke,	51 "	51 "
Diameter of journals of propeller shaft,	16 "	16 "
Diameter of propeller,	16	16
Face of "	5	5
Pitch at periphery,	34	36
" " hub,	27½	29½
Number of blades in propeller,	three.	three.
Height of trunk above keelsons, on up stroke,	21	21
Calculated number of revolutions,	36	36

The Pioneer will probably make her trial trip early in the ensuing month, and the City of Pittsburg, not yet launched, will be completed in the month of September, when the effective power of the engines, speed of vessels, and the difference in the pitch of the propellers, be fully tested. K.

For the Journal of the Franklin Institute.

Notes on the U. S. Steam Propeller Legaré, with remarks on the Relative Advantages of the Propeller and Side Wheel.

The steamer Legaré was originally built for the revenue service, and subsequently transferred to the Navy Department for the use of the Coast Survey—is built of iron, of the following dimensions: 140 feet long, 24 feet beam, depth of hold 11 feet: a three masted schooner, rigged with fore-topsail; has one beam engine (condensing, sitting athwart ship; diameter of cylinder 32 inches, stroke of piston 36 inches. When these notes were taken she had an Ericsson's propeller of the following dimensions, viz:

	Feet.	*Inches.*
Diameter,	9	6
Length of blades,	4	1
Width of blades,	2	½
Length of inclined plane of screw,	36	
Diameter of drum,	5	6
Width of drum,		18
Pitch of inclined plane of screw,	21·75	

Six of them, whose combined length is less than one convolution of the screw by 5·24 feet.

The data was taken from the results of 10 hours steaming under the most favorable circumstances of wind and sea, in the Chesapeake Bay. Wind calm, sea smooth, engine working well, making an average of 31·3 revolutions per minute. Pressure of steam, 14·7 pounds per square inch, above the atmosphere. Vacuum average 24·5 inches: consumption of anthracite coal, average 267 pounds per hour: natural draft. The propeller being fractions of a true screw, and supposing it to have had no slip, would have propelled the vessel at the rate of 680·775 feet per minute, or 6·67 knots per hour; but the vessel actually logged but 6 knots, showing a loss of nearly 11 per cent. by slip. This I consider was her maximum performance while I had charge of her.

Her minimum was her perfect inability to make steerage way against a double reefed topsail breeze, in an effort to make a harbor in the Chesapeake bay, during the same season, although there was a pressure of 40 pounds to the square inch, and making 32 to 33 revolutions. She was supplied with Ericsson's surface condenser and fresh water apparatus, to supply the boilers, which gave her all the advantages of economy and efficiency to be derived from that source: notwithstanding this pressure of steam, with the advantages of a good vacuum, I believe she would have fell off, had it not been for the very great velocity of the current of water that was driven past the rudder by the action of the propeller, which at once shows the great advantage in the steering of a vessel with a propeller, over that of the side wheel.

This event, then as now, convinces me, that with the screw propeller

equal speed cannot be obtained with that of paddle wheels, even with equal amounts of fuel, other things being equal, as was suggested in the April number of the Journal.

This may be, and was, one of those extreme cases; but always when running head to wind or sea, when the progress of the ship was much retarded, there was no sensible diminution in the revolution of the engine, and hence none in the consumption of fuel.

I had ample opportunity to observe the same facts, while I was attached to the Princeton, but probably not to so great an extent. I do not wish to be understood by this, as opposing the adoption of screw propellers as a mode of propulsion, but to the contrary: yet I would have them adopted without taking from the paddle-wheel, any portion of their well earned merit and efficiency, for I doubt very much whether there can be found any one in this age of the propeller, who would hazard his reputation on propelling a ship of the *Pacific's tonnage* across the Atlantic in 9 days and 20 hours, under such circumstances as to produce the greatest benefit to the builders or company. There is no one who would doubt for a moment, that if the Legaré had been a side-wheel steamer, with equal amounts of power developed under the same circumstances, but that she would have gone into the harbor, or her consumption of fuel reduced, instead of having to fall off, and take a course opposite to her destination, in order to avail herself of the prevailing wind. Had it been necessary for her to have laid to, then one of the great advantages of the screw propeller would have been manifest, viz: the perfect ease with which the ship could have been managed. I have been in the Princeton when lying to in a gale of wind, with the propeller making from 4 to 5 turns per minute, and the effect was astonishing; the rudder being placed in a position to counteract the effect of the storm sails, and the propeller making just turns enough to cause a current by the rudder, by which means she would never make but little, if any leeway, an advantage that her officers understood and appreciated. Again, should it be necessary to suspend the operation of the propeller, it can be done in a few moments; so also can it be put in operation with as much despatch. But not so with the paddle wheels, requiring as they do, from 2 to 4 hours to prepare them for sailing to the best advantage, and as many more to refit them for steaming, to say nothing of the danger attending the operation. The paddle wheel has, however, all the advantages of speed and economy where equal tonnage is used. In regard to paddle wheel steamers, there is no doubt but that for all increase of resistance a decrease of revolution, and necessarily a diminution in the consumption of fuel, ensues. The Mississippi, of 12 furnaces, when by a heavy head wind or sea, her speed became less, the number of furnaces in operation was reduced to 8, or the fires were banked. Observation has gone far to prove one of two things, viz: that there is no decided advantage in using sail, with a side wheel steamer, unless the wind is perfectly fair, or if the wind is abeam, there is no economy in steaming with the sails set, further than to overcome the resistance of the wheels, which is rather expensive sailing. In either case, if she were a propeller, the sails could be used with good effect, showing their great advantage in this respect. Hence I conclude, that for duties where speed and regularity are essential, the paddle wheel

has the advantage pre-eminently; while the advantages of the propeller consist in its allowing the sails to be used, and full broadsides with advantage, on vessels of war, without the usual interruption of wheel-houses, &c. Its ready adaptation as an auxiliary to sailing vessels and freight vessels of moderate capacity. S.

For the Journal of the Frankinl Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute. Session, 1850–51. *By* Dr. L. Turnbull.

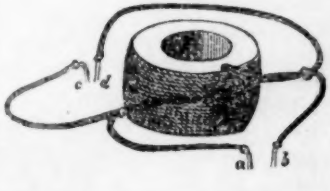
Continued from page 407.

Magneto-Electricity.—The power which electricity of tension possesses of causing an opposite electrical state in its vicinity, has been expressed by the general term induction, which, as it has been received into scientific language, may also, with propriety, be used in the same general sense to express the power which electrical currents may possess of inducing any particular state upon matter in their immediate neighborhood, otherwise indifferent; this is the meaning given to it by Professor Faraday, in his *Experimental Researches*. Previous to the experiments of this distinguished philosopher, certain results of importance had been obtained by Amperè, showing the induction of electrical currents by his experiment of bringing a copper disc near to a flat spiral; also his repetition of Arago's experiment, and the wonderful effects produced by Sturgeon Moll and Henry. Still, Faraday remarks, it appeared unlikely that these could be all the effects which induction by currents could produce.

These considerations, with their consequences, stimulated him to investigate experimentally, with the hope of obtaining electricity from ordinary magnetism.

Though baffled in his early attempts, he at last succeeded in laying open a new branch of electro-dynamics, which vies in interest and importance with the fundamental discovery of Œrsted. "A copper wire 203 feet long, was passed in the form of a helix, around a large block of wood, and an equal length of a similar wire was wound on the same block, and in the same direction, so that the coils of each helix should be interposed, but without metallic contact, between the coils of the other. The two ends of one of the helices, *a* and *b*, as in Fig. 16, were connected with a galvanometer, and those of the other, at *c* and *d*, with a strong galvanic battery, with a view of ascertaining whether the passage of an electric current through one helix, would create or induce a current in the adjoining helix. It was found that the galvanometer needle indicated a current to have been elicited in the under wire, at the moment of completing and breaking the circuit but that, in the interval, no deflexion took place. And likewise, the induced currents readily magnetized a sewing needle, while the electric current along the inducing coil was in

Fig. 16



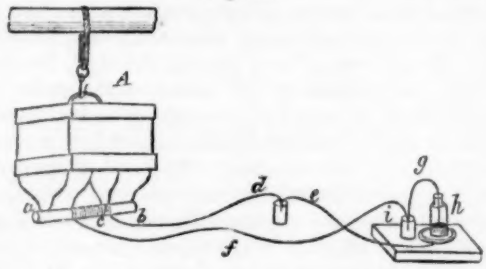
the act of beginning or ceasing to flow, but at no other period. An electric current transmitted from a galvanic battery through a conducting coil, does not induce a current in an adjoining coil, except at the moment of making or breaking the circuit. When the circuit is closed, the direction of the induced current is opposite to that of the inducing one, but when it is broken, the direction of both is the same." To this phenomenon, Professor Faraday gave the name of volta electric induction. The power of magnetism, to induce or create an electric current in an adjoining body, is greater than that of electricity itself. One of the most convenient of Professor Faraday's arrangements to represent this action, consisted of a hollow cylinder of pasteboard, around which two compound coils were adjusted. On connecting one of these coils with a galvanic battery, the other coil moved the needle of the galvanometer, and magnetized steel needles, as in the experiment just described. But when a cylinder of soft iron was introduced into the pasteboard case, and a galvanic current transmitted as before, the effect on the galvanometer was much greater. This effect results from the induction of magnetism in the bar of iron, which magnetism causes the increased amount of electricity in the coil connected with the galvanometer. To the phenomena in the last experiment, Professor Faraday gave the name of magneto-electricity. With such an instrument, he caused convulsions in the leg of a frog, and when the ends of the induced wire were armed with charcoal points, sparks of electric-light were obtained at the moment the galvanic circuit was broken, and closed through the inducing wire. When a permanent magnet is placed in a coil of wire, a current of electricity is set up in the wire. While the magnet remains in the coil at rest, no action is perceptible; but on removing it, another current is perceived. The currents move in opposite directions. These singular phenomena, which establish such new and intimate relations between galvanic and magnetic action, and supply additional evidence in favor of Amperè's beautiful theory of magnetism, have led to an experiment, by which, at first view, an electric spark appeared to be derived from the magnet itself.—*Faraday's Researches, Nov.* 1831.

Amperè's theory was, that all magnetic properties of bodies can be referred to currents of electricity circulating around each particle of those bodies.

After Professor Faraday had announced his experiment of obtaining sparks from the induced wire, other attempts were made to effect the same object with a magnet, without the aid of galvanism. The first person who succeeded in Great Britain, was Professor Forbes, of Edinburgh, who operated with a loadstone, which had been presented to the University of Edinburgh by Dr. Hope. A helix of copper wire was formed around the middle of a cylinder of soft iron, which was of such length that its extremities reached from one pole of the loadstone to the other. On applying and withdrawing the soft iron cylinder to and from the poles of the loadstone, magnetism was alternately created and destroyed within it. At these periods of transition, electric currents were induced in the helix surrounding the soft iron; and when, at these instants, metallic contact between the conducting wires of the helix was broken, an electric spark was visible. The arrangement of the apparatus

is shown in Fig. 17, A is the magnet, *a b* a cylindrical collector of soft iron passing through the axis of the helix *c*, and connecting the poles of

Fig. 17.



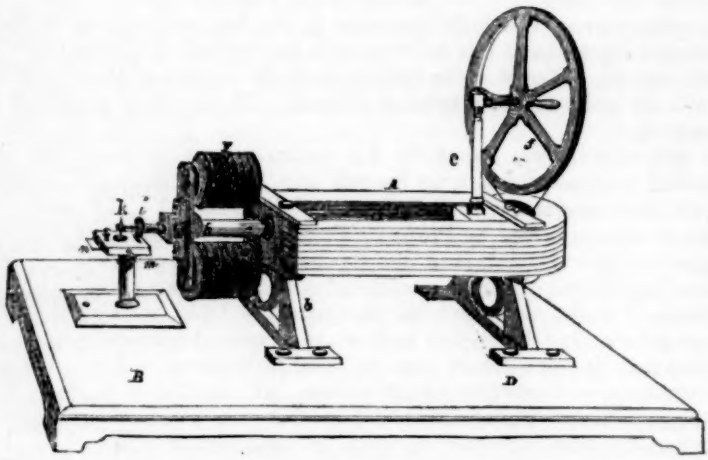
the magnet. The one termination *d e* of the wire passed into the bottom of a glass tube *h*, half filled with mercury, in which the wire terminated. The other extremity *f*, of the helical wire, communicated by means of the cup of mercury *i* with the iron wire *g*, the fine point of which may be brought by the hand into contact with the surface of the mercury in *h*, and separated from it at the instant when the contact of the connector *a b* with the poles of the magnet is effected. The spark is produced in the tube *h*.

In this experiment, therefore, the electricity was obtained from the helix, and was induced in it by the soft iron, while in the act of acquiring or losing magnetism. (*Phil. Trans. of Ed.*, 1832.) The same experiment was performed by Professor Faraday, with a loadstone belonging to Professor Daniel; and shortly before the experiment of Mr. Forbes, Nobili and Antinori succeeded with an ordinary steel magnet. M. Pixii, of Paris, performed this experiment in 1832, with great effect. He caused a strong horse-shoe magnet to revolve horizontally upon an axis, so that its poles should pass in rapid succession, in front of a soft iron armature or keeper of the same form. (*An. de Ch. et de Ph.*) Mr. Saxton, a native of Philadelphia, but at that time residing in London, made an important improvement upon the apparatus of Pixii.

At the meeting of the British Association, at Cambridge, in June, 1833, Mr. Saxton exhibited his improvement, which consists in making he keeper the lighter body revolve, while the magnets remain at rest; and, secondly, the interruptions, instead of being produced by the revolution of points, were made by bringing one of the ends of the wire over a cup of mercury, and depending on the jerks given to the instrument by its rotation for making and breaking the contact with the mercury. Fig. 18 represents the complete machine. A is a compound horse-shoe magnet, composed of six or more bars, and supported on the rests, *b*, *e*, which are screwed firmly on the board, B D, into the rest; *e* is screwed on the brass piller *c*, carrying the large wheel *f*, having a groove in its circumference, and a handle by which it can readily be revolved on its axis; a spindle passes from one end of the magnet to the other between the pole, and projects beyond them about three inches, where it terminates in a screw at *h*, to which the armatures, to be described immediately, are attached; at the further extremity is a small pulley, over which a catgut

band passes, by means of which, and the multiplying wheel *f*, the armatures can be revolved with great velocity. The armatures as seen at F, are nothing more than electro-magnets; two pieces of round iron are attached to a cross piece, into the centre of which the spindle *h* screws; round each of these bars is wound in a continuous circuit a quantity of insulated copper wire, one end being soldered to the round disc, *i*, the other connected with the copper wire passing through, but insulated from it by an ivory ring. By means of the wheel and spindle, each pole of the armature is brought in rapid succession opposite each pole of the magnet, and that as near as possible, without absolutely touching. The two armatures differ from one another. The one termed the quantity-armature is constructed of stout iron, and covered with thick insulated wire. The other, the intensity-armature, is constructed of slighter iron, and covered with from 1000 to 2000 yards, according to the size of the instrument, of fine insulated wire.—(*Lond. & Ed. Phil. Mag. Vol.* IX, *page* 360.)

Fig. 18.



The quantity-armature is for exhibiting the magnetic spark, inducing magnetism in soft iron.

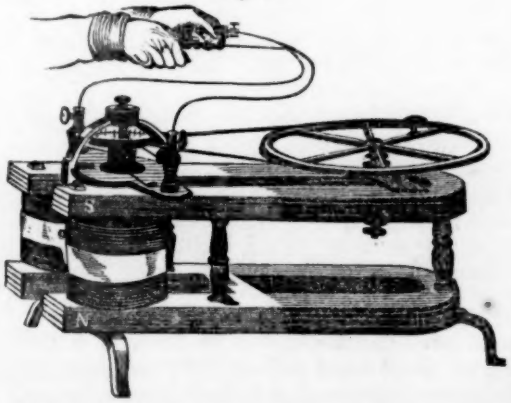
The intensity-armature, is employed for medical purposes, and for effecting chemical decomposition. This arrangement of armatures was an improvement by Wm. Clark of London, and was based upon the discoveries of Prof. Henry of this country, who found that an electrical current of quantity would induce a current of intensity, and on the other hand, that a current of intensity would make sensible a current of quantity.

According to Faraday, in the wire of the helix of magneto-electric machines, (as, for instance, in Mr. Saxton's beautiful arrangement,) an important influence of the principles of these actions of induced currents, is evidently shown. From the construction of the apparatus, the current is permitted to move in a complete metallic circuit of great length, during the first instants of its formation: it gradually rises in strength, and is then suddenly stopped by the breaking of the metallic circuit; and

thus great intensity is given by induction to the electricity, which at that *moment* passes. This intensity is not only shown by the brilliancy of the spark and the strength of the shock, but also by the necessity which has been experienced of well insulating the convolutions of the helix, in which the current is formed; and it gives to the current a force at these moments very far above that which the apparatus could produce, if the principle of the inductive action of a current were not called into play.—(*Experimental Researches*, *Dec.* 8, 1834, *vol.* 1, *page* 343.)

Another important improvement, or modification of the magneto-electrical machine, was made in 1838, by Prof. Page, of the U. S. Patent Office, According to Dr. Page's plan, two straight keepers, surrounded by coils of insulated copper wire, revolve between two powerful horse-shoe magnets, though much shorter keepers are used now than those he introduced. The steel magnets are fixed, with the south pole of one above the north pole of the other, at such a distance as just to allow the armatures to pass between them. The keepers are mounted on each side of a vertical shaft, in such a manner, that both keepers shall be passing between the opposite poles at the same time. They revolve in a horizontal direction around this shaft, while those before in use, revolved vertically around a horizontal axis. A little instrument, called a pole changer, was invented by Dr. Page, of Washington. It is composed of two semi-cylindrical pieces of silver, fixed on the axis upon which the keeper revolves, but insulated from that axis, and from each other. To each of the segments is soldered one end of the wire composing the coil. Two silver springs press upon these segments, and convey the electricity to the screw cups or point desired, by means of wires attached to them. The pole changer on the shaft, conveys the alternating currents in a constant direction to the screw cups, with which some metallic handles can be put in connexion for the purpose of giving shocks, &c. His improved form of the machine is represented in Fig. 19, made by Mr. D. Davis, Jr., of Boston, for Prof. Franklin Bache, of this city.

Fig. 19.



"Respecting the efficacy of this machine, the following is the substance of a statement in a letter from Dr. W. F. Channing, of Boston,

to Prof. Hare, of this city. The unmitigated shocks from this machine are insupportable. When the wires which break the shocks are removed, the current becomes sufficiently uniform to be competent for electrolysis, or imparting magnetism to iron, included in a long helix of fine wire, comprised in the circuit of the helices of the machine. When sent through a circuit of a mile, the current from this machine was found abundantly competent to work the telegraph of Prof. Morse."—(*Hare on Electro-Magnetism*, p. 131.)

In Liebig's Annual report, (Vol. III, part 1, page 146,) it is stated that considerable improvements have recently been made in the magneto-electric machine.

Sinstedem, (Pogg. Ann, LXXVI, 29, 195, 524,) and Stöhrer, (Ibid, LXXVII, 467,) have published instructive suggestions for rendering them more perfect. Stöhrer has employed these machines, as it appears, with a satisfactory result, for the purposes of the electric telegraph. (Ibid, 485.) Dujardin, of France, has also used this instrument before the Committee on Electric Telegraphs, appointed by the legislative assembly: the circuit he employed being 140 leagues, by uniting two telegraphic wires at Paris and Lille, and employing a single magneto-electro machine, he caused his telegraphic machine to work with complete success, transmitting and printing under the eyes of the committee eighty-two letters a minute.—*Bulletin de la Société d'Encouragement de l'Industrie Nationale, May*, 1850, *p.* 221.

Many observers who have availed themselves of the magnetic-electro apparatus for the production of electric currents, have observed that the excitation of the current does not keep pace, as might have been supposed, with the velocity of rotation. In numerous cases, indeed, a maximum of the current-force has been observed to attend a certain velocity of rotation. This deportment has been explained by assuming that the production and disappearance of the magnetism in the iron cores requires a certain time. This explanation has, however, been proved by Lenz (*Petersb. Acad. Bull.* VII, 257.) to be sufficient for those cases only, in which the induction-currents set up are of a very low intensity, when, for instance, they have to pass through a great length of wire in addition to the coils in which they are developed. On the other hand, in the case of currents, which have only to surmount comparatively slight external resistances, their force increases, for equal velocity of rotation the more slowly, and, as this velocity increases, attains a maximum the sooner, the smaller the external resistance.

Lenz accounts for this phenomenon by the reaction of the induced currents upon the iron cores, by which magnetism is reproduced in the latter; the maximum of this magnetism coincides with the maximum of the current-force; not, however, for that very reason, coinciding with the maximum of the primary magnetism of the iron cores induced by the magnet, it consequently causes a deviation of those points of the rotation in which the induced current-force is at zero, or a maximum. The amount of deviation increases with the force of the current, and consequently with the velocity of rotation. It is therefore clear, why, in the commutators of the machine, which are empirically adjusted for the developement of the greatest current-force, (always in the

same direction,) the change does not take place at the moment when the iron cores are opposite to the poles of the magnet; if the matter be only superficially examined; this is the instant at which the iron cores might be supposed to have attained the greatest possible degree of magnetism, and at which the induction in the copper wires would be at zero.—*Liebig's Ann. Rep. Chemistry*, 1848, *p.* 246.

Electro-Magnetic Telegraphs.

When Œrsted's splendid discovery was announced, and it was seen that feeble electric currents would produce a variety of magnetic actions, electrical telegraphing received a new impulse, and numerous forms of telegraphic apparatus were proposed, of which I will now endeavor to give an account, describing each step in the progress of discovery, and commencing with

Amperè's Telegraph.

In 1820, Amperè, in consequence of a suggestion of La Place, was led to devise the first telegraph, employing the deflexion of the magnetic needle, by the agency of the galvanic fluid, which, however, it appears that he did not carry out practically. His plan was to have as many magnetic needles as there are letters of the alphabet, which might be put in action by the passage of currents through metallic conductors, made to communicate successively with the battery, by means of keys, which could be pressed down at pleasure, and might give place to a telegraphic correspondence that would surmount all distance, and be as prompt as writing speech to transmit thought.—*Ann. de Chem. et de Phys.* xv. 73.

The second telegraph was suggested by Peter Barlow, F. R. S., in 1825, that an instantaneous telegraph might be established by means of conducting wires and compasses.—*Edinburg Philos. Jour. Vol.* xii. *p.* 105.

In 1828, Victor Triboaillet de Saint Amand proposed to establish a telegraphic line from Paris to Brussels, by a metallic wire, about a line or a line and a half in diameter. He recommended to cover the wire with shellac, upon which was to be wound silk, very dry, which should be covered with a coating of resin. The whole was then to be put into glass tubes, carefully luted up with a resinous sustance, and secured by a last envelope, then varnished over and hermetically sealed; then, by means of a powerful galvanic battery, he would communicate the electricity to the conducting wire, which would transmit the current to the opposite station, to an electroscope, destined to render sensible the slightest influence, and left to each one to adopt at pleasure, the number of motions to express the words or letters which they might need.—*Report of Academy of Industry, Paris, from Vail's E. M. Telegraph, p.* 138.

Fechner's Telegraph.

Fechner, of Leipsic, in 1829, in his hand book of galvanism, remarks, that there is no doubt that if the insulated wires of twenty-four multipliers, corresponding to the several letters of the alphabet, and situated at Leipsic, were conducted under ground to Dresden, at

which place the battery were situated, we could thus obtain a means, probably not very expensive, comparatively speaking, of transmitting intelligence from one place to the other, by means of signals properly agreed on before hand.

I confess it is a very seductive idea, to imagine that by future development of a system of such connexions at some time, a communication between the central point and the parts of a country can be established, which shall consume no time like communication between the central point of our organism and its members, by means of the nerves by what appears to me a very analogous arrangement.—*Lehrbuck des Galvanismus, p.* 269.

"Dr. Ritchie, in a lecture at the Royal Institution, London, in 1830, endeavored to illustrate the suggestion of Amperè, and exhibited a model of a telegraph constructed after his description; the arrangement was, however, very complex from the number of wires employed, &c., and Dr. Ritchie was not sanguine as to the ultimate practicability of the scheme."—*Journal of the Royal Institution, p.* 183.

Schilling's Telegraph.

In 1832 and 3, Baron Schilling, of Caunstadte, a Russian Counsellor of State, had occupied himself with an electro-magnetic telegraph. The Baron, who was attached to the Russian embassy, at Munich, at the time when Sömmering was engaged with his galvanic telegraph, already described, was much interested in the experiments of the latter, and shortly after Œrsted's discovery of the deflexion of the magnetic needle, Schilling was led to devise a needle telegraph, which consisted in a certain number of platinum wires, insulated, and united in a cord of silk, which put in action, by the aid of a species of key, 36 magnetic needles, each of which were placed vertically in the centre of a multiplier. Schilling was the first who adapted to this kind of apparatus, an ingenious mechanism, suitable for sounding an alarm, which when the needle turned at the beginning of the correspondence, was set in play by the fall of a little ball of lead. An improved form of his instrument was exhibited at the Bonn meeting of naturalists, by Dr. Munke, in 1835, (*Isis. Nog.* 1836,) and is described in detail, in Gehler's Physikalisches Wörterbuch, 1838, vol. IX, iii. In this improved instrument, light discs of card board, attached to magnetic needles enclosed in galvanometer coils, are moved by the galvanic or magneto-electric current. Five similarly prepared magnets, arranged so that the round disks of card-board were only seen edgeways, were connected by wires with the distant source of electricity; according to the direction in which the current was sent, the magnet was deflected to the right or left, in the one case showing to the observer, the one side, in the other case, the reverse of the card-board disc; thus ten separate signals were obtained, which by reference to a telegraphic dictionary, gave any required number of signals."

"Professor Henry, Secretary of the Smithsonian Institution, Washington, says, that in 1832, nothing remained to be discovered in order to reduce the proposition of the electro-magnetic telegraph to practice. I had shown that the attraction of an armature, could be produced at any distance, and had designed the kind of a battery and coil around the

magnet to be used for this purpose. I had also pointed out the fact of the applicability of my experiments to the electro-magnetic telegraph. I make a distinction between the terms discovery and invention. The first relates to the development of new facts; the second to the application of these or other facts to practical purposes."—*House Case, p.* 93.

To be Continued.

For the Journal of the Franklin Institute.

Prices of Cast Iron Pipes for Street Use.

The prices of cast iron pipes for street use, has become so much reduced in consequence of the low price of iron and improved method of manufacture, that a comparison between the prices of this year and those paid in 1820, may be interesting.

	Prices in 1820.			Prices in 1850.
22	inch pipe, per foot	$6	25	
20	" " "	5	00	$2 75
16	" " "	3	33½	2 18
10	" " "	2	40	1 03
8	" " "	1	66⅔	82
6	" " "	1	10	62
4	" " "		64	40
3	" " "		45	26

On Œrsted's Experiments on Falling Bodies. By Prof. J. R. Young.*

"One of the most important observations first made by Œrsted, and since then confirmed by others, was, that a body falling from a height, not only fell a little to the east of the true perpendicular—which is, no doubt, due to the earth's motion—but that it fell to the *south* of that line; the cause of this is at present unexplained. It is, no doubt, connected with some great phenomena of gravitation which yet remains to be discovered."*—*Lit. Gaz., March* 22, 1851, *p.* 221.

The explanation of this phenomenon is very easy. Suppose a heavy body to be let fall from a point vertically over P (see diagram, p. 373:) when it is let go, the body will have a progressive velocity towards the east *greater* than the velocity of P at the foot of the vertical; and this velocity it will preserve throughout its fall, which, from the nature of gravity, must be in *a vertical plane* through P and C, the centre of the earth. Now the point P, at the foot of the vertical line, *recedes* from this plane towards the *north* during the descent of the body, since it describes a circle oblique to it round the axis of the cone: the body, therefore, will fall towards the *south* of the P as well as towards the east. If the experiment be performed in south latitude, the deviation will, of course, be *north* instead of south.

† London Mechanics' Magazine, No. 1447.

* I regret that, from the loss of my library, I cannot now refer to the *Mecanique Celeste;* but I well remember that Laplace somewhere enters into a mathematical discussion of the phenomena: it is either in the first or second volume.

Remarks on Screw Propelling. By W. Gordon, *Lieut. R. N.**

Sir,—It appears to be a general, and, in my opinion, an erroneous doctrine, that the most favorable results in *screw propelling* are to be obtained from small angles, or low pitches—in the form of the propeller. I have always maintained that there can be no loss of power, whatever may be the angle, (within certain limits,) but that a greater angle than that which is usually given will produce the *same* velocity in fine weather, with *fewer* revolutions of the screw; and whilst steaming against adverse winds, will be found still more conducive to the realization of *propelling* power, with the smallest expenditure of *engine* power.

These views have already been amply supported by the cases of the *Great Britain* and *Princeton;* but the publication in your 1442d. No., of experiments in the *Dwarf,* with screws of various angles, and the same diameter, has afforded the most convincing proof possible of the truth of what I have advanced. Unfortunately, most experiments in screw-propelling are referred to the vicious standard of *apparent* slip—a method which can only perpetuate error; but in the *Dwarf* experiments the *actual horse-powers exerted* are likewise given, by which means correct conclusions can be arrived at.

1. With an angle of 24°.12′, a speed of 9·11 knots was obtained with an expenditure of 168·8 horse power.

2. When the angle was increased to 30°.6′, with a screw of similar diameter and area, a speed of 9·05 knots was obtained with an expenditure of only 154 horse-power, and a reduction in the revolutions of the screw, of more than ($\frac{1}{5}$) *one-fifth.*

There can be no stronger proof than these experiments of the superiority of the long pitch; but the *apparent* slip is stated in the first case to be only 30·4 per cent., whilst with a much smaller power, producing the same velocity, it was 36·3 per cent. Any theory, therefore, which is founded on the apparent slip of a screw must be false, and of no practical use. I could comment upon experiments with the screw of different areas, which are likewise connected with the preceding experiments.

London, April 9, 1851.

Translated for the Journal of the Franklin Institute.

Analogy between Light and Heat.

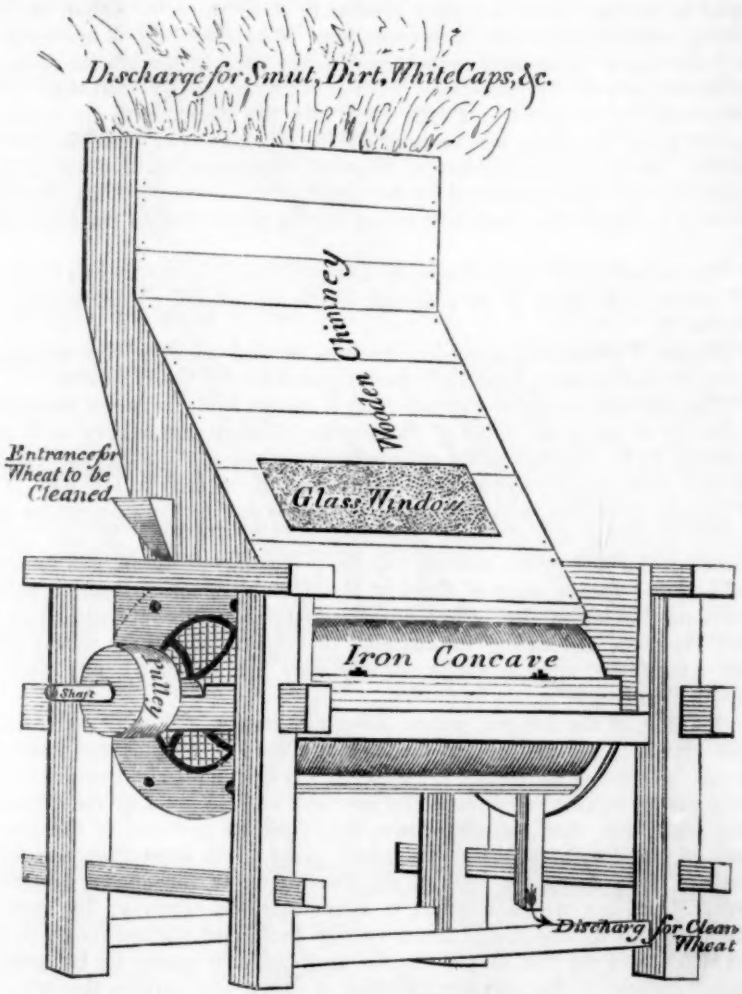
There are few subjects of physical science which present at present greater theoretical interest, than the experimental demonstration of the perfect analogy which exists between the phenomena of light and of heat. Thus, by various experimenters, the phenomena of reflexion, refraction, dispersion, interference, double refraction, and polarization, have been demonstrated in each of these agents. In a memoir published in the *Annales de Chimié et de Physique, Novembre,* 1850, *p.* 267, Mm. de la Provostaye and Desains, have shown by a very interesting series of experiments there recorded, that the oil of turpentine and solution of sugar, which exercise the power of rotating the plane of polarization of light, exert the same influence over heat, and produce a rotation in the same direction, and of the same amount.

* London Mechanics' Magazine, No. 1447.

Description of an Improved Smut Machine. Invented and Patented by JEHU HOLLINGSWORTH, *Zanesville, Ohio, April 22d,* 1851.*

Figure 1 is a front view of the machine, when adjusted in its stand or frame.

Fig. 1.



It consists of a horizontal concave made of cast iron. An iron shaft passes through this concave, to which is fitted a number of beaters; there is a pulley on one end of this shaft, by which it and the beaters are made to revolve 350 to 450 times per minute, according to the amount of wheat to be cleaned, the size of the machine, &c.

* See Journ. Frank. Ins., vol. xxi, 3d series, p. 382.

The hopper through which the grain enters the machine, also the discharging spout at the other end, are both seen in this figure. The iron concave is open at both ends so as to admit *air freely;* it is also *open along the top*—this aperture being about *one foot wide, and extending from one end of the concave to the other.* Around this opening is closely fitted *a wooden chimney*, which becomes smaller as it ascends; this chimney is open at its top; there is a *glass window in it*, to show the action of the wheat, when the machine is in operation. When the beaters are revolving, the wheat is scoured round the concave until it reaches the *opening at the top*, where by centrifugal force it is driven up the chimney, until, overcome by its gravity, it falls back into the concave, to be scoured again; whilst the smut, dirt scoured off, the white caps or chaff, &c., *being lighter*, are forced, *at the instant they are disengaged*, up and out of the chimney, by *a blast* generated by the action of the beaters. This cleaning process is repeated at each revolution till the grain reaches the discharging spout.

The wheat can be *scoured more or less*, as desired, by means of a number of *aprons in the back of the chimney*, which are explained particularly in Figure 2.

Figure 2 represents a vertical section, or end view, of the concave, flanches and beaters, wooden chimney, *partition in it, and aprons.*

The cast iron concave extends from A round to B; between these two points *it is open;* the *front of the wooden chimney* commences at B and ascends to F, the *back of the chimney* commences at A and ascends to E. In this chimney, between the points A and B, is seen *an end view of a triangular partition*, which extends from one end of the chimney to the other, dividing the chimney *lengthwise* into two parts. In the space between the *back of the chimney and this triangular partition*, is a number of *movable aprons*, each of them so fixed on a wire (one end of which rests on the top of the partition, the other passing through the back of the chimney, and *ending in a crank*), that by turning these *wire cranks* (to which the aprons inside the chimney are fastened), any desired inclination can be given to them.

Starting at the hopper, where the grain enters, *following the arrows*, the wheat is scoured round the concave until it reaches the point B; here, there being *no concave to confine it*, it is driven (at right angles to the face of the beaters) *up between the partition and the front of the chimney;* the smut, dirt, chaff, or white caps, &c., pass up and out of the top of the chimney with the blast; *the wheat, freed of its impurities*, and *being heavier*, falls down *the back of the chimney* on to the above described *movable aprons*, which conduct it again into the concave; by moving these aprons in one direction it is *carried back, and retained longer* in the concave, and by this *means scoured over and over again;* or by moving these aprons in the *opposite direction*, it is hurried rapidly through the machine, so that a *forward* or *backward* inclination given to these aprons, will effect a little or a *great deal of scouring;* in this respect they are *complete regulators*, governing the scouring of wheat in the most effective manner.

For millers who require an *extraordinary amount of scouring*, there are connected with this machine *four rubbers*, which can be fastened to the

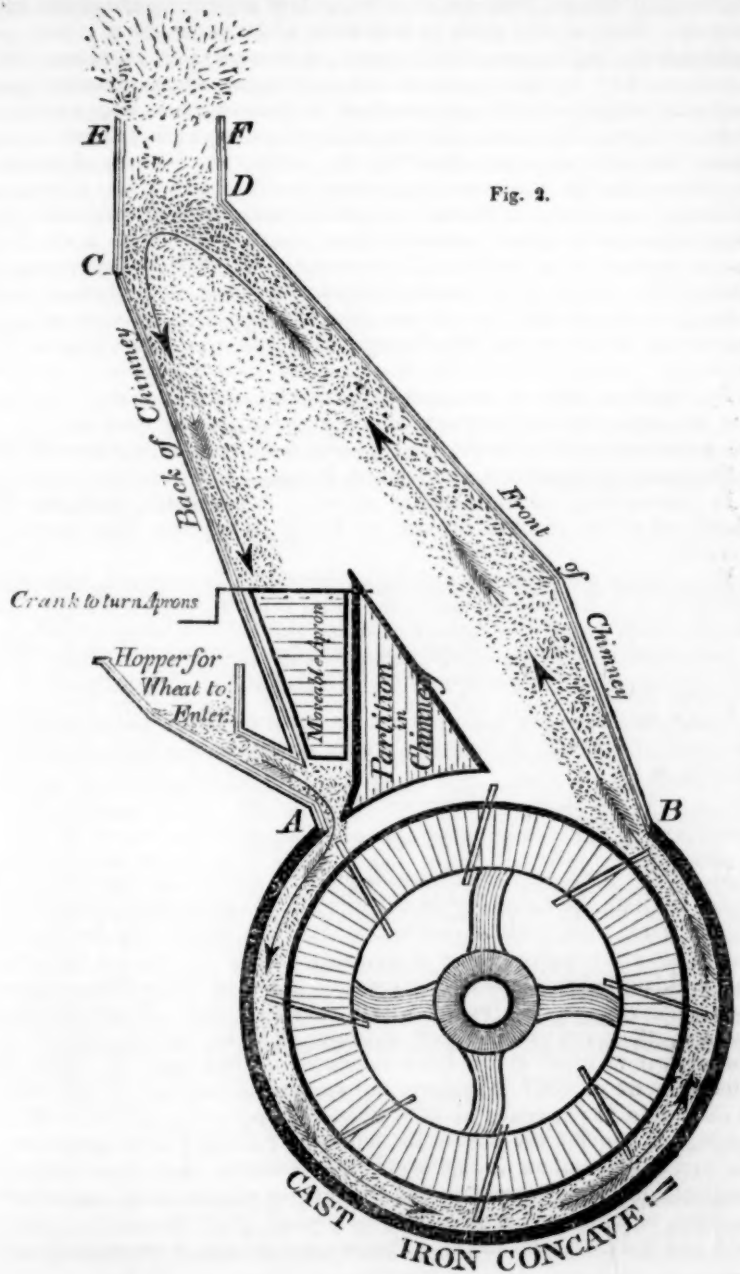

E
F
D
C
Back of Chimney
Front of Chimney
Crank to turn Aprons
Hopper for Wheat to Enter
Moveable Apron
Partition in Chimney
A
B
CAST IRON CONCAVE

Fig. 2.

edges of the beaters in a few minutes, and so adjusted as to scour *very severely*. They can be used, or not, as may be desired.

This blast, which carries off the smut, white caps, and other impurities, is generated by the same action of the beaters that scours the wheat; the air for it is supplied at the open ends of the concave, and finds an ample and unobstructed vent out of the top of the chimney, so that this machine, by one and the same action of the beaters (without any increase of power), becomes a smut mill, scourer, and extensive fan.

Particular attention is desired to this fact, that the blast carries out the smut and impurities the instant they are disengaged (which is the only proper time to be rid of them); it does not allow them to be conveyed through the body of the wheat (blackening the ends of the berries), but it is acting all the time, driving the impurities out of the chimney at each revolution, as fast as they are disengaged, by the scouring action of the beaters.

By this fan action of the machine, a current of air is always drawing into the open ends of the concave, carrying with it any dust floating in the surrounding atmosphere; hence, instead of being dirty, the contrary is the case; it cleans the room in which it runs.

In consequence of the peculiar action of this machine, throwing the wheat out of the concave at each revolution, it requires little power to drive it.

For country mills, no other cleaning apparatus is required, excepting a shaking or rolling screen, before the grain is put through this smut mill. For merchant mills, it is capable of doing the heaviest work in the most thorough manner: for its *safety against fire*, its durability, its efficacy as a thorough smut mill, scourer, and fan, see the following certificates.

These machines are manufactured by Beaumont & Hollingsworth, *Zanesville, Ohio*, who will promptly execute any orders that may be sent to them.*

Experiments on Charcoal.†

M. Violet, the government commissioner of gunpowder, has presented to the Institute the following observations, resulting from experiments to obtain a charcoal with a constant amount of carbon. He has experimented on seventy-five species of wood, native and foreign, but especially on the black alder (*bourdaine*, *resprun*), a sort of white timber nearly resembling prickwood (*fusain*), which is mostly used. If wood be carbonized, the quantity of carbon obtained is in an inverse ratio to the temperature to which it has been submitted by the process. Thus, at a temperature of 250° Reaumur, the amount of carbon is 50 per cent.; at 300° it is 33 per cent.; at 400° about $\frac{20}{100}$ per cent.; and at 1500°—the highest temperature obtainable, being the melting point of platinum—the amount of carbon is but $\frac{15}{2000}$. The quantity of carbon originally contained in wood is separated, in the process of carbonization, into two portions, of which one remains in the charcoal, while the other passes off with like volatile substances. This separation varies according to the

* See advertisement on the cover of this Journal.

† London Architect, 1851.

temperature employed in the act of carbonisation: at 250° the carbon remaining in the charcoal is double that which has escaped; between 300° and 350° both portions are equal. Not even the highest temperature, however, could change charcoal into pure carbon. Charcoal invariably contains gas even after being exposed to the highest temperature. At 250° the quantity of gas is half the amount of carbon; at 300° one-third; at 350° one-fourth; at 400° one-twentieth; at 1500° one-hundredth part. If wood is carbonized in perfectly closed vessels, it yields three times more charcoal than by the ordinary process. Treated in this way, wood undergoes a real process of fusion at a temperature of from 300° to 400°; it becomes semi-fluid, glutinous, and presents, when cooled, a black, lustrous mass, from which all organic texture has disappeared—resembling, in a word, coarse coal. This process is, after all, nothing but a repetition of that grand operation by which nature has produced those extensive strata of coal all over the globe. Charcoal obtained in close vessels contains ten times more cinders than that made in the ordinary way—a sure sign that the volatile substances of the wood carry with them a great quantity of mineral substances during the process of carbonization, although the latter be not volatile by themselves. *Proceed. Paris Academy.*

Method of obtaining Oxygen from Atmospheric Air. By M. Boussingault.*

Lavoisier resolved atmospheric air into its constituents by keeping a confined portion for twelve days in contact with mercury heated nearly to its boiling-point. Boussingault has attempted to use baryta for the purpose of extracting the oxygen from the atmospheric mixture in larger proportion. The method is simple; the air is conducted over pieces of baryta at a dark red heat until it has become converted into peroxide of barium; the oxygen is subsequently again expelled by the application of a more intense heat. The moisture and carbonic acid usually present in the air do not materially interfere with the process. The baryta, however, contained so much alumina and silica, that after repeated use it became caked, and hence no longer of any use. Pure baryta was free from this inconvenience. According to Boussingault, on the large scale, on using 10 kilogrammes of baryta, which absorb 730 litres of oxygen, and should again part with it, 600 litres is the quantity always obtained in practice. Hence with furnaces in which 100 kilogrammes of baryta distributed in 8 to 10 tubes can be heated at once, from 24,000 to 30,000 litres of oxygen may be produced in twenty-four hours.—*Comptes Rendus, vol.* xxxii, pp. 266, 267.

Translated for the Journal of the Franklin Institute.

Deep Sea Soundings.

M. Faye, at the meeting of the Academy of Sciences of Paris, 20th January, described an apparatus which he considered as new, and presenting valuable facilities for deep sea soundings, requiring no line, and

* London, Edinburgh, and Philosophical Magazine, June, 1851.

giving with accuracy the perpendicular depth and the set of the submarine currents. It consists of a stout cylinder open below, and filled with a liquid sufficiently lighter than water, to cause the apparatus to float; it is sunk by having two cannon balls attached to it, which are released by a trigger striking against the bottom, when the apparatus returns to the surface. The distance and direction of its point of emvergence from that of its sinking, will give the resultant of the submarine currents; and it has, moreover, attached to it a light fan, whose revolutions will measure the space moved over. (This is Saxton's apparatus for measuring the velocity of curren's of water.) A little vessel attached and provided with valves to close when the vessel begins to rise, will bring to the top a specimen of the bottom water, and an overflow thermometer, (on Walferdin's principle); a modification of the apparatus itself will measure the temperature. At subsequent sessions of the academy, the proposed apparatus was shewn to be not new, but it remains to be seen whether it may not prove very useful.

On some Properties peculiar to Caoutchouc, and their Applications. By Mr. Brockedon.*

Caoutchouc is a vegetable constituent, the produce of several trees. The most prolific in this substance are, *Siphonia caoutchouc Urceola elastica, Ficus elastica*, &c. Of these, the *Siphonia caoutchouc* extends over a vast district in Central America,—and the caoutchoc obtained from this tree is best adapted for manufactures. Over more than 10,000 square miles in Assam the *Ficus elastica* is abundant. The *Urcela elastica*, (which produces the Gintawan of the Malays) abounds in the islands of the Indian Archipelago. It is described as a creeper of growth so rapid, that in five years it extends 200 feet, and is from 20 to 30 inches in girth. This tree can, without being injured, yield by tapping from 50 to 60 lbs. of caoutchouc in one season. A curious contrast is exhibited in the tardy growth of the tree from which the gutta percha is obtained. This tree does not come to its prime in less than from 80 to 120 years. The produce cannot be obtained but by the sacrifice of the tree. It is found in a concrete state between the bark and the wood after the tree has been cut down; and it is in this condition that, having been scraped out, it is sent to our market. When coagulated by evaporation or agitation, caoutchouc separates from the aqueous portion of the sap of the trees which yield it. This solid and fluid cannot afterwards be re-united, any more than butter is capable of mixing with the milk from which it is separated. Caoutchouc is a hydro-carbon. This chemical character belongs to all varieties of the substance, and many other vegetable constituents, though they differ materially in physical qualities. Some specimens are harder than gutta percha itself, while others never solidify, but remain in the condition of birdlime or treacle. The process termed the *vulcanizing* of caoutchouc was discovered by Mr. Thomas Hancock in 1843. A sheet of caoutchouc immersed in melted sulphur, absorbs a portion of it, and at the same time it undergoes some important changes in many of its characteristic properties. It is no longer affected by climatic temperature:—it is neither hardened by cold,

* London Athenæum, April, 1851.

nor softened by any heat which would not destroy it. It ceases to be soluble in the solvents of common caoutchoc, while its elasticity becomes greatly augmented and permanent. The same effect may be produced by kneading sulphur into caoutchouc by means of powerful rollers; or the common solvents naphtha and spirit of turpentine may be charged with a sufficient amount of sulphur in solution to become a compound solvent of rubber. In these cases articles may be made in any required forms before heating for the change of condition. It is necessary, however, for this purpose, that the form should be carefully maintained during the exposure to the heat necessary to effect the vulcanization, which leaves it in a normal state. A vulcanized solid sphere of $2\frac{1}{2}$ inches in diameter when forced between two rollers a quarter of an inch apart was found to maintain its form uninjured. In fact, it is the exclusive property of vulcanized caoutchouc to be able to retain any form impressed on it, and to return to that form on the removal of any disturbing force which has been brought to act on it. Caoutchouc slightly expands and contracts in different temperatures: it is also capable of being condensed under pressure. A cube of $2\frac{1}{4}$ inches, impactly secured, was subjected to a force of 200 tons. The result was, a compression amounting to one-tenth; great heat appeared to have been evolved; and the excessive elasticity of the substance caused a fly-wheel weighing 5 tons to recoil with an alarming violence. The evolution of heat from caoutchouc under condensation is a property possessed by it in common with air and the metals. It differs, however, from the latter in being able to exhibit cold by re-action. Mr. Brockedon stated that he had raised the temperature of an ounce of water two degrees in about fifteen minutes by collecting the heat evolved by the extension of caoutchouc thread. He refers this effect to the change in specific gravity. He contends, that this heat thus produced is not due to friction; because the same amount of friction is occasioned in the contraction as in the extension of the substance,—and the result of this contraction is to reduce the caoutchouc thus acted on to its original temperature. Attention was directed to some of the latest applications of the elastic force of caoutchouc.—*Proceed. Roy. Inst. March* 21, 1851.

Translated for the Journal of the Franklin Institute.

Reflexion of Light from the Surface of Liquids.

The following are the conclusions of M. Jamin, from a series of experiments recorded in the *Annals de Chimié et de Physique*, for February, 1851:—

1st, Liquids surfaces polarize light incompletely and elliptically.

2nd, Liquids having a high index of refraction have a positive anomaly, or difference of phase between the principal components of the reflected motion.

3rd, This anomaly becomes negative, when the index is very small.

4th, There are substances, whose indices are about 1·4, whose polarization is rectilineal.

5th, The laws of the intensities and anomalies are represented by the formulæ of M. Cauchy.

6th, If substances are superposed, the reflexion from their surface of separation follows the same *laws*.

7th, In this case it is impossible to predict the value and the sign of the coefficient of ellipticity.

The memoir, moreover, includes a table of the constants of reflexion for a number of liquids.

Translated for the Journal of the Franklin Institute.

Formation of Minerals in the Moist Way.

M. de Senarmont, to whom we owe the valuable and ingenious experiments upon the conducting power of crystallized substances, has been engaged in the endeavor to form some of our common minerals occurring in veins, by the liquid way—and has succeeded in getting from solutions containing carbonic acid and sulphuretted hydrogen, and the alkaline sulphurets and bicarbonates, either alone or together, microscopical but perfectly formed crystals of the following substances:

Native metals—Copper, silver, mixed without alloying, arsenic.

Oxides—Hematite, quartz, red oxide of copper.

Carbonates, of magnesia, iron, manganese, cobalt, nickel, zinc, copper, (Malachite.)

Sulphate of Baryta.

Sulphurets of arsenic (Realgar,) antimony, bismuth, iron (Pyrites,) manganes, cobalt, nickel, zinc (blende,) copper.

Oxysulphuret of antimony.

Arseniosulphurets of iron (Mispikel) silver.

Antimoniosulphuret of silver.

"What I proposed to myself was, to establish by experimental proofs, the opinion controverted, but to me very probable, which attributes the filling of concretionary veins to the thermul incrusting deposits, and to shew that the formation of a great number of the minerals which are there met with, whether crytallized or amorphous, does not always require conditions or agents very different from actual causes.—*Comptes Rendus de l'Academie des Sciences de Paris, 24 March*, 1851.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 19, 1851.

S. V. Merrick, President, in the chair.
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary. } Present.

The minutes of the last meeting were read and approved.

Donations were received from The Royal Irish Academy, Dublin; The Royal Institution of Great Britain, London; The Governor of Min-

nesota; H. Haupt, Esq., Harrisburg; Elwood Morris, Esq., Chilicothe, Ohio; Pofessor S. S. Haldeman, Columbia, and Messrs. A. Hart, Professor John F. Frazer, and W. C. Grimes, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer read his statement of receipts and payments for the month of May.

The Board of Managers and the Standing Committees reported their minutes.

New candidates for membership in the Institute (1) were proposed, and those proposed at the last meeting (4) were duly elected.

The Committee on the Cabinet of Minerals and Geological specimens reported, that the collections of the Institute were so far arranged as to admit of the room being thrown open for the use of the members.

Dr. Rand, Chairman of the Committee on Meetings, brought before the members a specimen of silvered glass, consisting of a cup manufactured by the New England Glass Company, being the first manufactured for sale in this country. It was of great beauty, resembling solid silver, and was much admired by the members present: the process was not known, but we suppose it to be Drayton's. The agents for the sale of the article are Messrs. Muzzey & Monroe, of this city.

Mr. Wm. Winter exhibited a new ventilating chimney cap, of galvanized iron, consisting of a square base and three circular pieces, pointed at the top and bottom, the lower angles overlapping the open spaces for the exit of the heated air. It has a concave top on three standards so as to prevent any downward draught. The great advantage claimed to be derived from the circular pieces, is the greater amount of expansion allowed for the heated air, and the prevention of side currents of cold air.

Mr. J. A. Maynard, of Boston, exhibited to the meeting his improved patent hot air and water tuyeres for blacksmiths' forges, and made the following remarks:

This tuyere consists of a hot air chamber, and water nozzle, placed within the forge on the side, which can be extended to a greater or less distance, as the work may require. The arch nozzle, so termed, is filled with water, supplied from a vessel placed behind the forge. The pipes which supply it are tapped into the nozzle, and extend through the hot air chamber and the back of the forge, one conducts the water in, and the other, when steam is generated, passes it out at the top of the vessel that contains the water; there are two pipes connected behind the hot air chamber, the top one conveys the air from the bellows into the hot air chamber; and from thence it is blown hot, through the water nozzle into the fire, the nozzle being filled with water is defended from the action of the fire. No clinker can adhere to the nozzle and the arch form prevents it running in to clogg, there being no surface for it to rest upon; the iron being set low in the forge, it gives a body of coal between the tuyere and the iron, which prevents the blast from coming directly on the iron to burn it; the blast is blown a little upwards, which is an advantage. A wide or crooked piece of iron can be wrought as advantageously as a small or straight one; there is no chance for the coal to be consumed except around the iron that is being heated. On the end of the lower